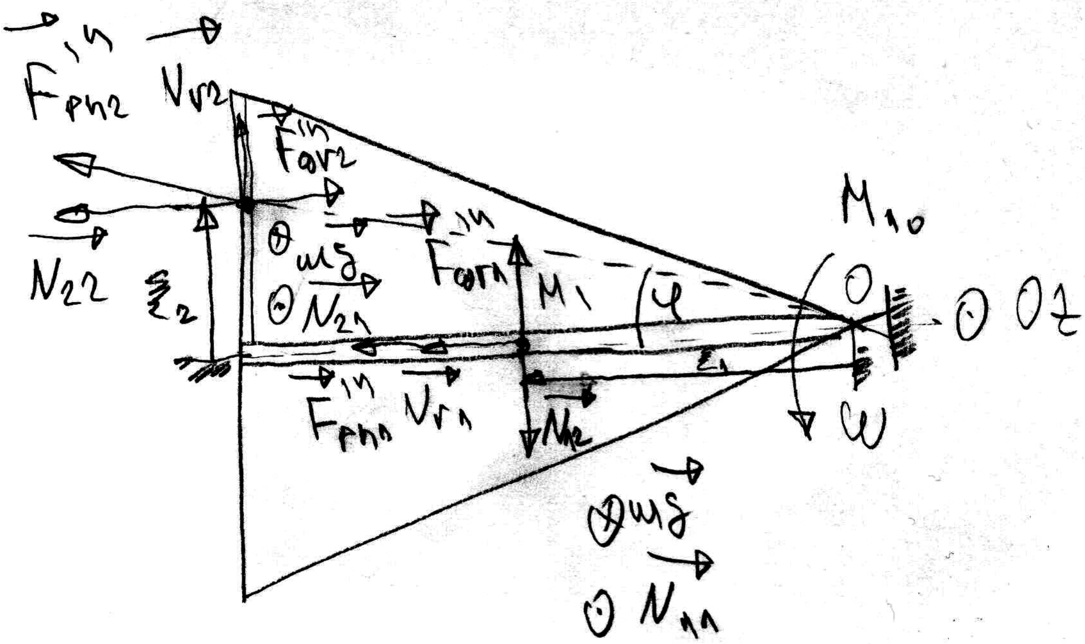
6.23 $\omega = const.$

$\dfrac{V_0, V_1}{\dfrac{V_0}{V_1} - ?}$



$$m\ddot{\xi}_2 = m\omega^2 a \sin\varphi, \quad \sin\varphi = \frac{\xi_2}{a}$$

$$\ddot{\xi}_2 = \omega^2 \xi_2 \qquad \ddot{\xi}_2 - \omega^2 \xi_2 = 0$$

$$\xi_2 = A_1 e^{\omega t} + A_2 e^{-\omega t}$$

$$m\ddot{\xi}_1 = m\omega^2 \xi_1$$

$$\ddot{\xi}_1 - \omega^2 \xi_1 = 0$$

$$\xi_1 = B_1 e^{\omega t} + B_2 e^{-\omega t}$$

$t_0 = 0$ $\quad \xi_{10} = 0, \; \dot{\xi}_{10} = V_1$

$\xi_{20} = 0, \; \dot{\xi}_{20} = V_0$

$$\dot{\xi}_1 = \omega B_1 e^{\omega t} - \omega B_2 e^{-\omega t}$$

$$\dot{\xi}_2 = \omega A_1 e^{\omega t} - \omega A_2 e^{-\omega t}$$

$$A_1 = \frac{V_0}{2\omega}, \quad A_2 = -\frac{V_0}{2\omega}$$

$$B_1 = \frac{V_1}{2\omega}, \quad B_1 = -\frac{V_1}{2\omega}$$

$$\xi_1 = \frac{V_1}{2\omega}\left(e^{\omega t} - e^{-\omega t}\right)$$

$$\xi_2 = \frac{V_0}{2\omega}\left(e^{\omega t} - e^{-\omega t}\right)$$

$$\xi_{21} = \frac{a}{2}, \quad \xi_{11} = \sqrt{a^2 - \frac{a^2}{4}} = \frac{a\sqrt{3}}{2}$$

$$\frac{a}{2} = \frac{V_0}{2\omega}\left(e^{\omega t_1} - e^{-\omega t_1}\right) (1)$$

$$\frac{a\sqrt{3}}{2} = \frac{V_1}{2\omega}\left(e^{\omega t_1} - e^{-\omega t_1}\right) (2)$$

$$\frac{(1)}{(2)} \qquad \frac{V_0}{V_1} = \frac{1}{\sqrt{3}} = \frac{\sqrt{3}}{3}$$

6.29

$\omega = const.$

a

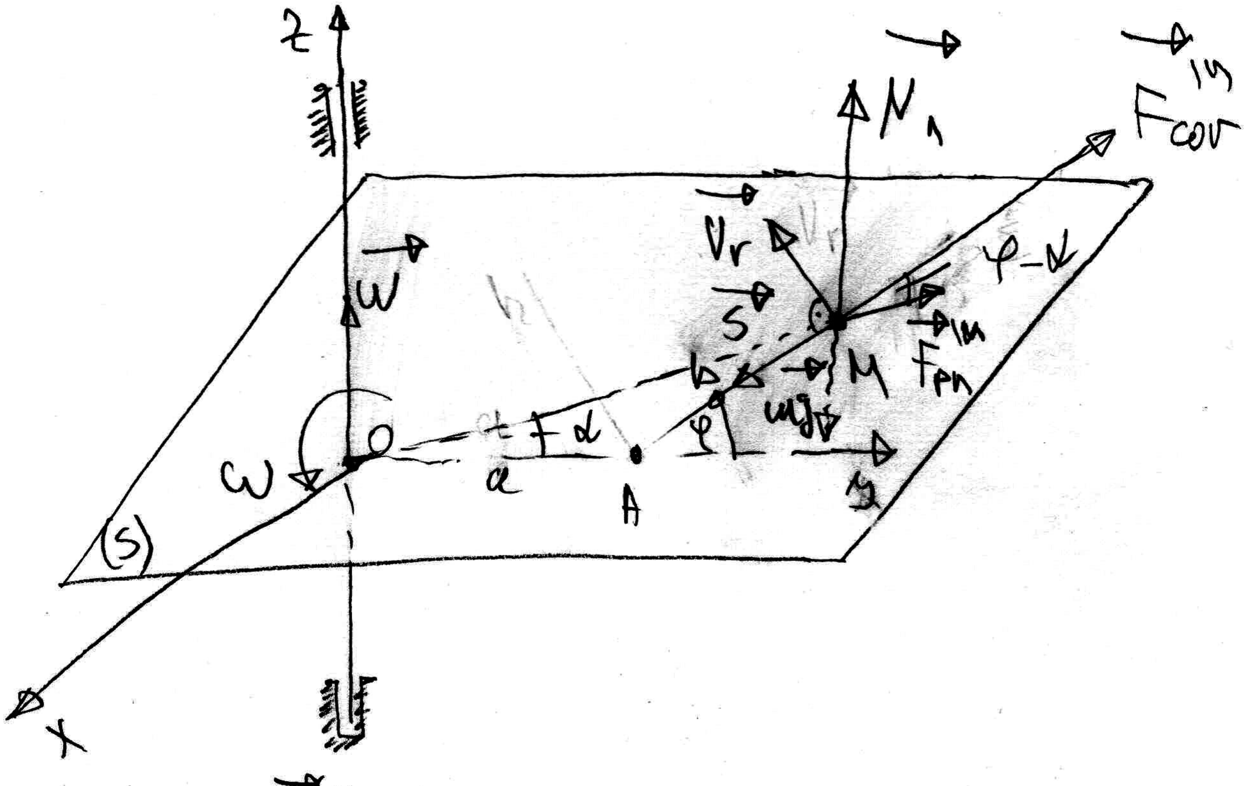
b

$\varphi_0 = 0$

$\dot{\varphi}_0 = \omega \sqrt{\frac{a}{b}}$

m

$V_{rel}(\varphi) - S_{max} - ?$



$T - T_0 = A(\vec{F}_{pn}^{in})$

$\frac{m}{2}(V_r^2 - V_0^2) = m\omega^2 \int_{a+b}^{c} l\,dl$

$c^2 = a^2 + b^2 + 2ab\cos\varphi$

$V_{r0} = r_0 \dot{\varphi}_0 = b\omega\sqrt{\frac{a}{b}} = \omega\sqrt{ab}, \ \alpha = \pi/2$

$V_{r0} = \omega\sqrt{ab}$

$$V_r^2 = V_{r0}^2 + \omega^2\left[c^2 - (a+b)^2\right] = ab\omega^2(2\cos\varphi - 1)$$

$$\boxed{V_r = \omega\sqrt{ab(2\cos\varphi - 1)}} \quad (9)$$

$$m\vec{a}_r = m\vec{g} + \vec{N}_1 + \vec{S} + \vec{F}_p^{\,in} + \vec{F}_{cor}^{\,in}$$

$$y: \; m\frac{V_r^2}{b} = S - F_{pn}^{in}\cos(\varphi - \alpha) - F_{cor}^{in}$$

$$S = m\omega^2 a(2\cos\varphi - 1) + 2m\omega V_r \cdot 1 +$$

$$+ m\omega^2 c\cos(\varphi - \alpha) = m\omega^2 a(2\cos\varphi - 1) +$$

$$+ 2m\omega^2\sqrt{ab(2\cos\varphi - 1)} + m\omega^2 c(\cos\varphi\cos\alpha +$$

$$+ \sin\varphi\sin\alpha) = \ldots =$$

$$= m\omega^2\left[2\sqrt{ab(2\cos\varphi - 1)} + 3a\cos\varphi - a + b\right]$$

$$S' = \frac{dS}{d\varphi} = m\omega^2\left[2\sqrt{ab}\,\frac{-2\sin\varphi}{2\sqrt{2\cos\varphi - 1}} - 3a\sin\varphi\right] = 0$$

$$\varphi = k\pi, \quad k = 0, 1, \ldots$$

$$S_{max} = m\omega^2\left(2\sqrt{ab} + 3a - a + b\right) =$$

$$= m\omega^2\left(2a + 2\sqrt{ab} + b\right)$$

6.33

R

$\omega = \sqrt{\frac{g}{R}}$

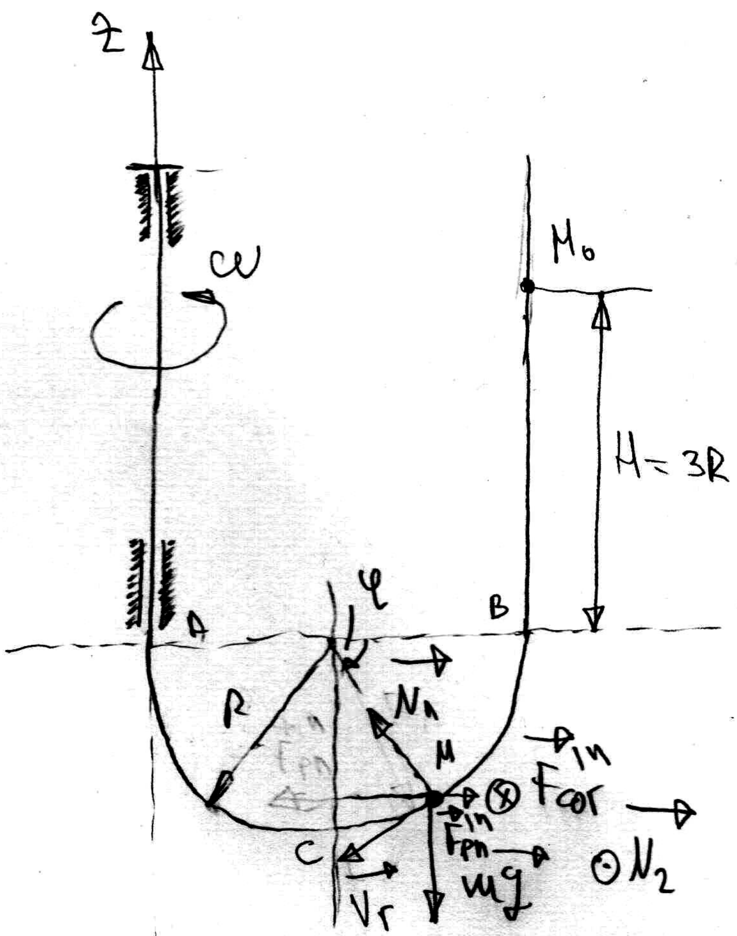
m

$H = 3R$

$V_{r0} = 0$

a) h - ?

b) N_C - ?



$$T - T_0 = \sum_i A(\vec{F}_i^r) + A(\vec{F}_e^{in}),$$

$$\frac{1}{2}m(V_r^2 - \underbrace{V_{r0}^2}_{0}) = mg(3R + R\sin\varphi) + m\omega^2 \int_{2R}^{R(1+\cos\varphi)} l\,dl \quad \Big| \cdot \frac{2}{m}$$

$$V_r^2 = 2gR(3+\sin\varphi) + \omega^2 R^2\left[(1+\cos\varphi)^2 - 4\right] =$$

$$= 6gR + 2gR\sin\varphi + \frac{g}{\cancel{R}} R^{\cancel{2}}\left[1 + 2\cos\varphi + \cos^2\varphi - 4\right] =$$

$$= 6gR + 2gR\sin\varphi + 2gR\cos\varphi + gR\cos^2\varphi - 3gR =$$

$$= gR(3 + 2\sin\varphi + 2\cos\varphi + \cos^2\varphi)$$

$$V_{rC} = V_r\big|_{\varphi=\pi/2} = \sqrt{gR(3+2)} = \sqrt{5gR}$$

$$V_{rA} = V_r\big|_{\varphi=\pi} = \sqrt{gR(3-2+1)} = \sqrt{2gR}$$

$$\underbrace{T_1}_{=0} - T_A = -mgh^*$$

$$-\frac{1}{2}\cancel{m}V_{rA}^2 = -\cancel{m}gh^*$$

$$V_{rA} = \sqrt{2gh^*} = \sqrt{2gR} \quad |^2$$

$$2g \cdot h^* = 2gR \quad |:2g$$

$$\boxed{h^* = R} \quad (a)$$

$$m\vec{a}_r = m\vec{g} + \vec{N}_1 + \vec{N}_2 + \vec{F}^{in}_{e} + \vec{F}^{in}_{cor}$$

$$n: \quad m\frac{V_{rC}^2}{R} = -mg + N_{1C} + 0 + 0 \Rightarrow$$

$$N_{1C} = mg(1+5) = 6mg$$

$$b: \quad N_{2C} = F^{in}_{corC} = 2mV_{Cr}\omega \cdot 1 = 2m\sqrt{\frac{g}{R}}\sqrt{5gR} =$$

$$= 2mg\sqrt{5}$$

$$\boxed{N_C} = \sqrt{N_{1C}^2 + N_{2C}^2} = mg\sqrt{36+20} = mg\sqrt{56} = \boxed{2mg\sqrt{14}} \quad (b)$$

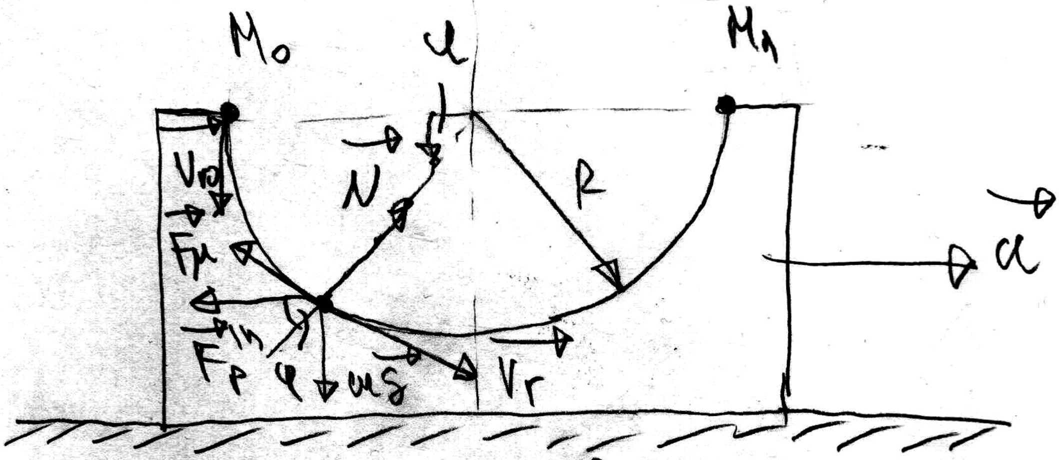
6.37 $a = g$

R

m

$\mu = 0{,}5$

V_{r0} - ?



$$m\vec a_r = m\vec g + \vec N + \vec F_\mu + \vec F_p^{in} + \vec F_{cor}^{in}, \quad F_p^{in} = ma, \quad F_{cor}^{in} = 0$$

$$n:\ m\frac{V_r^2}{R} = -mg\sin\varphi + N - ma\cos\varphi$$

$$N = mg(\sin\varphi + \cos\varphi) + \frac{m}{R}V_r^2, \quad V_r = R\dot\varphi$$

$$N = mg(\sin\varphi + \cos\varphi) + \frac{m}{\cancel{R}}R^{\cancel{2}}\dot\varphi^2 =$$

$$= mg(\sin\varphi + \cos\varphi) + mR\dot\varphi^2$$

$$t:\ m\frac{dV_r}{dt} = mg\cos\varphi - ma\sin\varphi - F_\mu, \quad F_\mu = N\mu$$

$$m\frac{d}{dt}R\dot\varphi = mg(\cos\varphi - \sin\varphi) - mg\mu(\sin\varphi + \cos\varphi) -$$

$$- mR\mu\dot\varphi^2$$

$$\frac{dR\dot\varphi}{dt}\cdot\frac{\overset{=\dot\varphi}{d\varphi}}{d\varphi} = \frac{\dot\varphi\, d(R\dot\varphi)}{d\varphi} = R\frac{\dot\varphi\, d\dot\varphi}{d\varphi} = \frac{1}{2}R\frac{d}{d\varphi}(\dot\varphi^2) = \frac{1}{2}\frac{d}{d\varphi}(R\dot\varphi^2)$$

$$m\frac{1}{2}\frac{d}{d\varphi}\left(R\dot{\varphi}^2\right) = mg\left(\cos\varphi - \sin\varphi - \frac{1}{2}\sin\varphi - \frac{1}{2}\cos\varphi\right)$$

$$-\frac{1}{2}mR\dot{\varphi}^2 \quad \Big| \cdot \frac{2}{m}$$

$$\frac{d\left(R\dot{\varphi}^2\right)}{d\varphi} + R\dot{\varphi}^2 = 2g\left(\frac{1}{2}\cos\varphi - \frac{3}{2}\sin\varphi\right)$$

$$u = R\dot{\varphi}^2, \quad V_r = R\dot{\varphi}, \quad V_r^2 = R^2\dot{\varphi}^2, \quad u = \frac{V_r^2}{R}$$

$$u' + u = g\left(\cos\varphi - 3\sin\varphi\right)$$

$$u = u_h + u_p$$

$$\lambda + 1 = 0 \qquad \lambda = -1$$

$$u_h = Ce^{-\varphi}$$

$$u_p = A\sin\varphi + B\cos\varphi, \quad u_p' = A\cos\varphi - B\sin\varphi$$

$$A\cos\varphi - B\sin\varphi + A\sin\varphi + B\cos\varphi = g\cos\varphi - 3g\sin\varphi$$

$$\left.\begin{aligned} A + B &= g \\ A - B &= -3g \end{aligned}\right\} +$$

$$2A = -2g \Rightarrow \boxed{A = -g} \qquad B = g - A = g + g = 2g$$

$$u_p = g\left(2\cos\varphi - \sin\varphi\right)$$

$$u = Ce^{-\varphi} + g\left(2\cos\varphi - \sin\varphi\right),$$

$$t_0 = 0 \quad \varphi_0 = 0, \quad u_0 = \frac{V_{r0}^2}{R} \quad \Big| \quad \frac{V_{r0}^2}{R} = C + 2g \Rightarrow C = \frac{V_{r0}^2}{R} - 2g$$

$$\frac{V_r^2}{R} = \left(\frac{V_{r0}^2}{R} - 2g\right)e^{-\varphi} + g\left(2\cos\varphi - \sin\varphi\right)$$

услов $V_r\big|_{\varphi=\pi} \geq 0$

$$\left(V_{r0}^2 - 2Rg\right)\frac{1}{R}e^{-\pi} - 2g \geq 0$$

$$V_{r0}^2 \geq 2gRe^{\pi} + 2gR$$

$$V_{r0}^2 \geq 2gR\left(1+e^{\pi}\right)$$