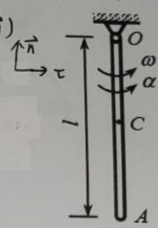
第十三章 达朗贝尔定理

13-1、质量为 m，长为 l 的均质杆 OA 绕 O 轴在铅垂平面内作定轴转动。设在某瞬时杆的角速度为 ω，角加速度为 α。试求惯性力系分别向定轴 O 点、杆的质心 C 点及端点 A 简化的结果。



解：向 O 点：

$$\begin{cases} \vec{F}_{gR} = -m\vec{a}_C = -m(\vec{a}_C^{\tau} + \vec{a}_C^{n}) = -m\left(\frac{l}{2}\alpha\vec{\tau} + \frac{l}{4}\omega^2\vec{n}\right) \\ M_{gO} = -J_O\alpha = -\frac{1}{3}ml^2\alpha \end{cases}$$

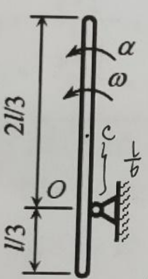
向 C 点：

$$\begin{cases} \vec{F}_{gR} = -m\left(\frac{l}{2}\alpha\vec{\tau} + \frac{l}{4}\omega^2\vec{n}\right) \\ M_{gC} = -J_C\alpha = -\frac{1}{12}ml^2\alpha \end{cases}$$

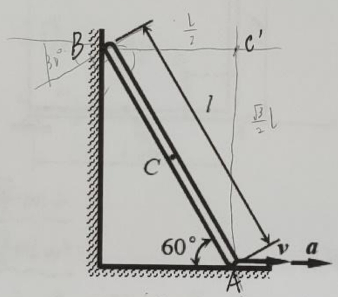
向 A 点：

$$\begin{cases} \vec{F}_{gR} = -m\left(\frac{l}{2}\alpha\vec{\tau} + \frac{l}{4}\omega^2\vec{n}\right) \\ M_{gA} = M_{gO} + M_A(\vec{F}_{gR}) = -\frac{1}{3}ml^2\alpha + m\frac{l}{2}\alpha\cdot l = \frac{1}{6}ml^2\alpha \end{cases}$$

13-2、设各物体质量皆为 m，尺寸如图所示。（a）求惯性力系对定轴 O 点简化的结果；（b）求惯性力系对质心 C 点简化的结果。



（a）



（b）

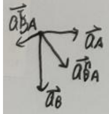
解：(a)

$$\begin{cases} \vec{F}_{gR} = -m(\vec{a}_C^{\tau} + \vec{a}_C^{n}) = -m\left(\frac{l}{6}\alpha\vec{\tau} + \frac{l}{6}\omega^2\vec{n}\right) \\ M_{gO} = -J_O\alpha = -\left(\frac{1}{12}ml^2 + \frac{1}{36}ml^2\right)\alpha = -\frac{1}{9}ml^2\alpha \end{cases}$$

(b) 瞬心：C'

$v_B = \frac{v_A}{l\sin 60^\circ}\cdot l\sin 30^\circ = \frac{1}{\sqrt{3}}v$

$\vec{a}_B = \vec{a}_A + \vec{a}_{BA}^{\tau} + \vec{a}_{BA}^{n}$



	$\vec{a}_B$	$\vec{a}_A$	$\vec{a}_{BA}^{\tau}$	$\vec{a}_{BA}^{n}$
大小	?	✓	?	✓
方向	✓	✓	✓	✓

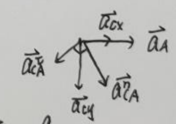
$a_{BA}^{n} = \omega^2 l = \left(\frac{v}{\frac{\sqrt{3}}{2}l}\right)^2 l = \frac{4v^2}{3l}$

向水平投影：

$0 = a_A - \frac{\sqrt{3}}{2}a_{BA}^{\tau} + \frac{1}{2}a_{BA}^{n}$

$\therefore \alpha = \frac{2}{\sqrt{3}l}\left(\frac{2v^2}{3l} + a\right)$

$\vec{a}_{Cx} + \vec{a}_{Cy} = \vec{a}_A + \vec{a}_{CA}^{\tau} + \vec{a}_{CA}^{n}$



	$\vec{a}_{Cx}$	$\vec{a}_{Cy}$	$\vec{a}_A$	$\vec{a}_{CA}^{\tau}$	$\vec{a}_{CA}^{n}$
大小	?	?	✓	✓	✓
方向	✓	✓	✓	✓	✓

向水平：$a_{Cx} = a_A + \frac{1}{2}a_{CA}^{n} - \frac{\sqrt{3}}{2}a_{CA}^{\tau} = \frac{a}{2}$

向竖直：$a_{Cy} = 0 + \frac{1}{2}a_{CA}^{\tau} + \frac{\sqrt{3}}{2}a_{CA}^{n} = \frac{4\sqrt{3}}{9l}v^2 + \frac{a}{2\sqrt{3}}$

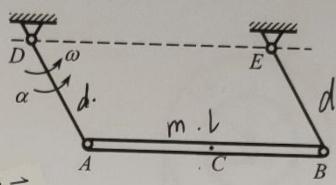
$$\therefore \begin{cases} \vec{F}_{gR} = -m\vec{a}_C = -m(\vec{a}_{Cx} + \vec{a}_{Cy}) = -\frac{1}{2}ma\vec{i} + m\left(\frac{4\sqrt{3}}{9l}v^2 + \frac{\sqrt{3}a}{6}\right)\vec{j} \\ |M_{gC}| = |-J_C\alpha| = \left|-\frac{1}{12}ml^2\cdot\frac{2}{\sqrt{3}l}\left(\frac{2v^2}{3l} + a\right)\right| = \frac{\sqrt{3}}{18}ml\left(\frac{2v^2}{3l} + a\right) \end{cases}$$

顺时针.

第十三章　达朗贝尔原理（动静法）

班级______________ 学号______________ 姓名______________

13-3、如图所示的平面机构中，AD、BE 为无重杆，$AD // BE$，且 $AD=BE=d$，均质杆 AB 的质量为 m，长为 l。求 AB 杆惯性力系向质心 C 简化的结果。



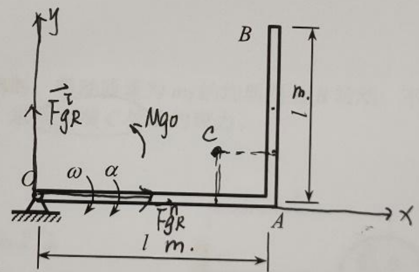
解：AB杆平动

$a_C^\tau = a_A^\tau = \alpha d$

$a_C^n = a_A^n = \omega^2 d$

∴ $\left\{\begin{array}{l} \vec{F}_{gR} = -m(\alpha d\vec{\tau} + \omega^2 d\vec{n}) \\ M_{gC} = 0 \end{array}\right.$

13-4、均质细折杆 OAB，OA、AB 长均为 l，质量均为 m，可绕 O 轴转动，图示瞬时其角速度为 ω，角加速为 α，求该细折杆的惯性力系向 O 点简化的大小和方向。(需将方向画在图上)



解：建系如图.

$\left\{\begin{array}{l} x_C = \dfrac{\frac{l}{2}+l}{2l} = \dfrac{3}{4}l \\ y_C = \dfrac{0+\frac{l}{2}}{2l} = \dfrac{1}{4}l \end{array}\right.$

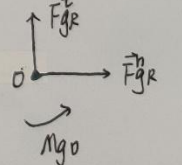
$OC = \sqrt{(\frac{3}{4})^2+(\frac{1}{4})^2}\; l = \frac{\sqrt{10}}{4}l$

∴ $F_{gR}^\tau = 2m a_C^\tau = 2m\,OC\,\alpha = \frac{\sqrt{10}}{2}ml\alpha$

$F_{gR}^n = 2m a_C^n = 2m\,OC\,\omega^2 = \frac{\sqrt{10}}{2}ml\omega^2$

$M_{gO} = |-J_O\alpha| = (\frac{1}{3}ml^2 + \frac{1}{3}ml^2 + ml^2)\alpha = \frac{5}{3}ml^2\alpha$

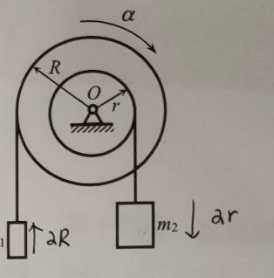
方向：



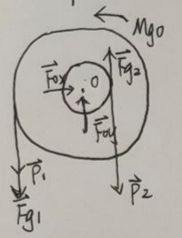
第十三章　达朗贝尔原理（动静法）

班级________________ 学号________________ 姓名________________

13-5、轮轴质心位于 O 处，对轴 O 的转动惯量为 J_O。在轮轴上系两个质量各为 m_1 和 m_2 的物体，若此轮轴以顺时针转动，用动静法求轮轴的角加速度 α 和轴承 O 的动约束力。



解：对整体：



$$M_{gO} = \alpha J_O$$

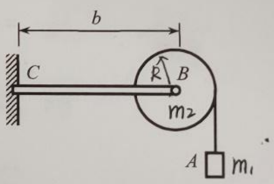
$$F_{g1} = m_1 \alpha R$$

$$F_{g2} = m_2 \alpha r$$

$$\begin{cases} \Sigma F_x = 0 & F_{Ox} = 0 \\ \Sigma F_y = 0 & -m_1 g - m_1 \alpha R - m_2 g + m_2 r \alpha + F_{Oy} = 0 \\ \Sigma M_O = 0 & -\alpha J_O - (m_1 g + m_1 \alpha R) R - m_2 \alpha r \cdot r + m_2 g r = 0 \end{cases}$$

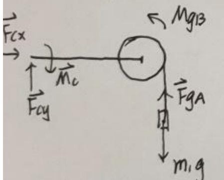
$$\therefore \begin{cases} \alpha = \dfrac{m_2 g r - m_1 g R}{J_O + m_1 R^2 + m_2 r^2} \\ F_{Ox} = 0 \\ F_{Oy} = \dfrac{(m_1+m_2) J_O + m_1 m_2 (R+r)^2}{J_O + m_1 R^2 + m_2 r^2} g \end{cases}$$

13-6、如图所示，质量为 m_1 的物体 A 下落时，带动质量为 m_2 的均质圆盘 B 转动，不计支架和绳子的质量及轴 B 处的摩擦，$BC=b$，盘 B 的半径为 R。求固定端 C 处的约束力。



解：

对整体：



对 B&A：

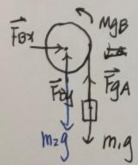
$$M_{gB} = \alpha J_B = \frac{1}{2} m_2 R^2 \alpha$$

$$F_{gA} = m_1 \alpha R$$

$$\begin{cases} \Sigma F_x = 0 & F_{Bx} = 0 \\ \Sigma F_y = 0 & F_{By} + m_1 \alpha R - m_1 g \; \underset{-m_2 g}{} = 0 \\ \Sigma M_B = 0 & -\frac{1}{2} m_2 R^2 \alpha - m_1 \alpha R^2 + m_1 g R = 0 \end{cases}$$

$$\therefore \begin{cases} \alpha = \dfrac{2 m_1 g}{m_2 R + 2 m_1 R} \\ F_{By} = \cancel{\dfrac{m_1 m_2}{m_2 + 2m_1} g} \quad \dfrac{3m_1 m_2 + m_2^2}{m_2 + 2m_1} g \end{cases}$$

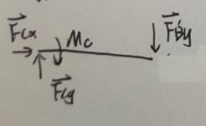
对 B 及 A：



对 BC：

$$\begin{cases} \Sigma F_x = 0 & F_{Cx} = 0 \\ \Sigma F_y = 0 & F_{Cy} - F'_{By} = 0 \\ \Sigma M_C = 0 & M_C + b F'_{By} = 0 \end{cases}$$

对BC：



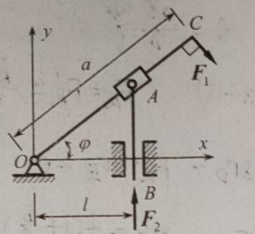
$$\therefore \begin{cases} F_{Cx} = 0 \\ F_{Cy} = \cancel{\dfrac{m_1 m_2}{m_2 + 2m_1} g} \quad \dfrac{3m_1 m_2 + m_2^2}{2m_1 + m_2} g & \text{竖直向上} \\ M_C = \cancel{\dfrac{m_1 m_2}{m_2 + 2m_1} bg} \quad \dfrac{3m_1 m_2 + m_2^2}{2m_1 + m_2} bg & \text{逆时针} \end{cases}$$

第十四章　虚位移原理

班级________________学号________________姓名____________________

14-1、在图示机构中，当曲柄 OC 绕 O 轴摆动时，滑块 A 沿曲柄滑动，从而带动 AB 杆在铅直导槽内移动，不计各构件自重与各处摩擦。求机构平衡时力 F_1 与 F_2 的关系。

$y_A = l\tan\varphi$　　$\delta r_C = a\cdot\delta\varphi$



$\therefore\ \delta y_A = l\sec^2\varphi\cdot\delta\varphi$.

$\therefore\ F_2\cdot\delta y_A - F_1\cdot\delta r_C = 0$

$\therefore\ F_2\cdot l\sec^2\varphi\cdot\delta\varphi - F_1\cdot a\cdot\delta\varphi = 0$

$\therefore\ \dfrac{F_1}{F_2} = \dfrac{l}{a\cdot\cos^2\varphi}$

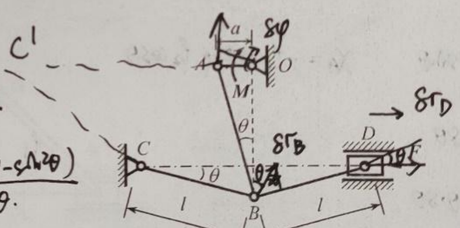
14-2、在图示机构中，曲柄 OA 上作用一力偶，其矩为 M，另在滑块 D 上作用水平力 F。机构尺寸如图所示，不计各构件自重与各处摩擦。求当机构平衡时，力 F 与力偶 M 的关系。

$M\delta\varphi - F\cdot\delta r_D = 0$

$BM = \dfrac{a}{\tan\theta}$

$C'B = \dfrac{BM}{\cancel{\tan\theta}\sin\theta} = \dfrac{a\cos\theta}{\sin^2\theta}$

$C'A = \dfrac{BM}{\tan\theta} - a = \dfrac{a(\cos^2\theta-\sin^2\theta)}{\sin^2\theta}$



$\therefore\ \dfrac{a\delta\varphi}{\delta r_B} = \dfrac{C'A}{C'B} = \dfrac{\cos^2\theta-\sin^2\theta}{\cos\theta}$

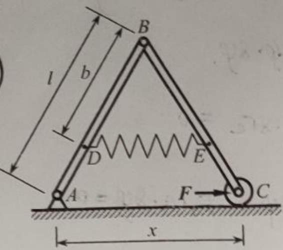
又 $\delta r_B\cdot\sin2\theta = \delta r_D\cdot\cos\theta$.　　$\therefore\ \dfrac{a\delta\varphi}{\delta r_D} = \dfrac{\cos^2\theta-\sin^2\theta}{\sin2\theta} = \cot2\theta$.

$\therefore\ \dfrac{F}{M} = \dfrac{1}{a}\cot2\theta$

第十四章　虚位移原理

班级________________ 学号________________ 姓名________________

14-3、如图所示两等长杆 AB 和 BC 在点 B 用铰链连接，又在杆的 D，E 两点连一弹簧。弹簧的刚度系数为 k，当距离 AC 等于 a 时，弹簧内拉力为零，不计各构件自重与各处摩擦。如在 C 点作用一水平力，杆系处于平衡，求距离 AC 之长。



$\frac{a}{l_0} = \frac{l}{b}$　　$l_0 = \frac{ab}{l}$

弹簧伸长　$\frac{b}{l}(x-a)$　　$F_k = F_k' = \frac{kb}{l}(x-a)$

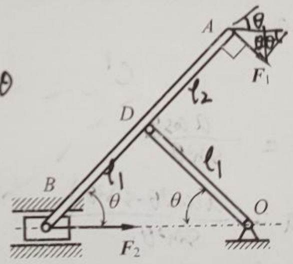
$F\cdot\delta r_C + F_k\cdot\delta r_D - F_k'\cdot\delta r_E = 0$

$\delta r_D = \frac{1}{2}(1-\frac{b}{l})\delta r_C$　　$\delta r_E = \frac{1}{2}(1+\frac{b}{l})\delta r_C$

$\therefore \left[F + \frac{kb}{l}(x-a)\frac{1}{2}(1-\frac{b}{l}) - \frac{kb}{l}(x-a)\cdot\frac{1}{2}(1+\frac{b}{l})\right]\delta r_C = 0$

$\therefore\ x = a + \frac{F}{k}(\frac{l}{b})^2$

14-4、图示结构在力 F_1 与 F_2 作用下在图示位置，不计各杆自重与各处摩擦，$OD=BD=l_1$，$AD=l_2$。求 F_1/F_2 的值。



$x_B = -2l_1\cos\theta$

$y_A = (l_1+l_2)\sin\theta$　　$x_A = -l_1\cos\theta + l_2\cos\theta$

$\therefore \delta x_B = +2l_1\sin\theta\cdot\delta\theta$

$\delta y_A = (l_1+l_2)\cos\theta\cdot\delta\theta$

$\delta x_A = -(l_2-l_1)\sin\theta\cdot\delta\theta$

$\therefore\ F_2\cdot\delta x_B + F_1\sin\theta\cdot\delta x_A - F_1\cos\theta\cdot\delta y_A = 0$

$\cancel{\therefore F_2(-2l_1\cos\theta)}$

$(F_2\cdot 2l_1\sin\theta + F_1\sin\theta\cdot(l_1-l_2)\sin\theta - F_1\cos\theta\cdot(l_1+l_2)\cos\theta)\cdot\delta\theta = 0$

$\therefore\ \frac{F_1}{F_2} = \frac{2l_1\sin\theta}{l_2+l_1\cos2\theta}$

$\frac{2l_1\sin\theta}{l_2+l_1\cos2\theta}$

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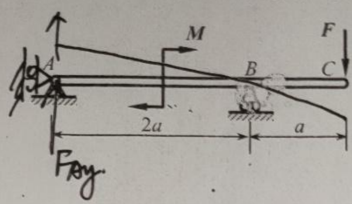
14-5、无重水平梁的支承和载荷如所示。已知力 F、力偶矩 M。用虚位移原理求支座 A 处的约束力。



$F_{Ax} \cdot \delta x_A = 0$　　$\therefore F_{Ax} = 0$

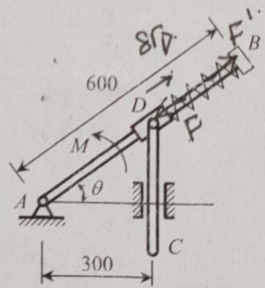
$F_{Ay} \cdot \delta y_A + F \cdot \frac{1}{2} \delta y_A + M \cdot \frac{\delta y_A}{2a} = 0$

$\therefore F_{Ay} + \frac{1}{2} F + \frac{M}{2a} = 0$

$\therefore F_{Ay} = -\frac{1}{2} F - \frac{M}{2a}$

14-6、图示滑套 D 套在直杆 AB 上，并带动杆 CD 在铅直滑道上滑动。已知 θ=0° 时弹簧为原长，弹簧刚度系数为 5kN/m，不计各构件自重与各处摩擦。用虚位移原理求在任意位置平衡时，应加多大的力偶矩 M?

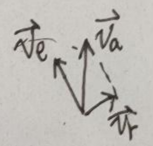
（不改）



原长 $l_0 = 0.3m$.

$M \delta\theta - F \cdot \delta r = 0$

$v_e = \frac{0.3}{\cos\theta} \cdot \omega$　　$v_r = \tan\theta \cdot v_e = \frac{0.3 \sin\theta}{\cos^2\theta} \cdot \omega$.



$\therefore \delta r = \frac{0.3 \sin\theta}{\cos^2\theta} \cdot \delta\theta$.

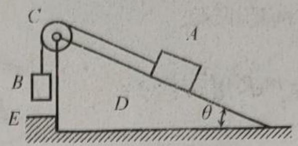
$\therefore M = F \cdot \frac{\delta r}{\delta\theta} = F \cdot \frac{0.3 \sin\theta}{\cos^2\theta} = k\left[0.3 - (0.6 - \frac{0.3}{\cos\theta})\right] \cdot \frac{0.3 \sin\theta}{\cos^2\theta}$

$= 450 \left(\frac{1}{\cos\theta} - 1\right) \frac{\sin\theta}{\cos^2\theta}$.

动力学综合问题

班级______________ 学号______________ 姓名____________________

综-1、如图所示，重物 A 质量为 m_1，沿楔体 D 的斜面下降，同时借绕过滑轮 C 的绳子使质量为 m_2 的物体 B 升。斜面与水平成 θ 角，滑轮与绳的质量和一切摩擦均不计。求楔体 D 作用于地板凸出部分 E 的水平压力。



对轮C.

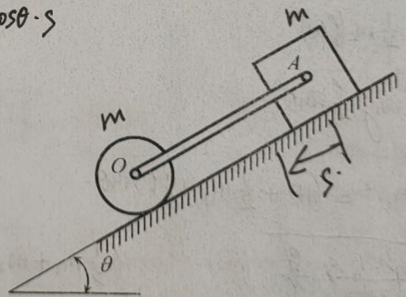
$(m_1r^2+m_2r^2)\alpha = (m_1 g\sin\theta - m_2 g)r$

$\therefore \alpha = \dfrac{m_1 g\sin\theta - m_2 g}{(m_1+m_2)r}$

$\therefore a_{Ax} = r\alpha\cos\theta = \dfrac{m_1 g\sin\theta - m_2 g}{m_1+m_2}\cdot\cos\theta$

$\therefore F_E = m_1 a_{Ax} = m_1\cdot\dfrac{m_1 g\sin\theta - m_2 g}{m_1+m_2}\cos\theta$

综-2、在图示系统中，纯滚动的均质圆轮与物块 A 的质量均为 m，圆轮的半径为 r，斜面倾角为θ，物块 A 与斜面间的摩擦因数为f。不计杆 OA 的质量。试求：(1)O 点的加速度；(2)杆 OA 的内力。



$\frac{1}{2}mv^2 + \frac{3}{4}mv^2 = 2mg\,s\sin\theta - f\,mg\cos\theta\cdot s$

$\therefore \frac{5}{4}mv^2 = 2mgs\sin\theta - fmg\cos\theta\cdot s$

$\therefore \frac{5}{2}mv\cdot a = v(2\sin\theta - f\cos\theta)\cdot mg$

$\therefore a = \frac{2}{5}(2\sin\theta - f\cos\theta)g$

对A: $ma = mg\sin\theta - fmg\cos\theta - F_{OA}$

$\therefore F_{OA} = -\frac{2}{5}mg(2\sin\theta - f\cos\theta) - fmg\cos\theta + mg\sin\theta$

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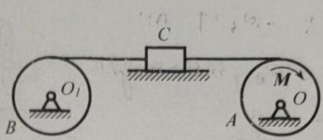
综-3、如图所示，轮 A 和 B 可视为均质圆盘，半径为 R，质量均为 m_1。绕在两轮上的绳索中间连着物块 C，设物块 C 的质量为 m_2，且放在理想光滑的水平面上。今在轮 A 上作用一不变的力偶 M，求轮 A 与物块之间那段绳索的张力。



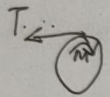
$$T=\frac{1}{2}m_2v_C^2+\frac{1}{2}\cdot\frac{1}{2}m_1R^2\cdot\omega^2\times2$$

$$=\frac{1}{2}m_2R^2\omega^2+\frac{1}{2}m_1R^2\omega^2$$

$$W=M\varphi$$

$$\therefore\ \frac{1}{2}(m_1+m_2)R^2\omega^2=M\varphi$$

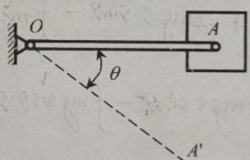
$$\therefore\ (m_1+m_2)R^2\omega\alpha=M\omega \qquad \therefore\ \alpha=\frac{M}{(m_1+m_2)R^2}$$



对A: $M-T\cdot R=\frac{1}{2}m_1R^2\cdot\alpha$

$$\therefore\ T=\frac{1}{R}\left(M-\frac{m_1M}{2(m_1+m_2)}\right)=\frac{m_1+2m_2}{2(m_1+m_2)R}\cdot M$$

综-4、均质细杆 OA 可绕水平轴 O 转动，另一端铰接一均质正方形盘，正方形盘可绕铰 A 在铅直面内自由旋转，如图所示。已知 OA 杆长 l，质量为 m_1；正方形盘边长为 R，质量为 m_2。摩擦不计，初始时 OA 杆水平，杆和正方形盘静止。求杆与水平线成 θ 角的瞬时：(1)杆的角速度和角加速度；~~(2)支座 O 的约束反力。~~ (不做



(1) $T=\frac{1}{2}\cdot\frac{1}{3}m_1l^2\omega^2+\frac{1}{2}m_2(l\omega)^2$

$$W=m_2gl\sin\theta+m_1g\frac{l}{2}\sin\theta$$

$$\therefore\ \left(\frac{1}{6}m_1+\frac{1}{2}m_2\right)l^2\omega^2=\left(m_2+\frac{1}{2}m_1\right)gl\sin\theta$$

$$\therefore\ \omega=\sqrt{\frac{6m_2+3m_1}{m_1+3m_2}\cdot\frac{g}{l}}$$

$$\left(\frac{1}{3}m_1+m_2\right)l^2\omega\cdot\alpha=\left(m_2+\frac{1}{2}m_1\right)gl\cos\theta\cdot\omega$$

$$\therefore\ \alpha=\frac{m_2+\frac{1}{2}m_1}{\frac{1}{3}m_1+m_2}\cdot\frac{g}{l}\cos\theta$$

(2). $\begin{cases}F_{Ox}= \\ F_{Oy}=\end{cases}$ 略. 不做

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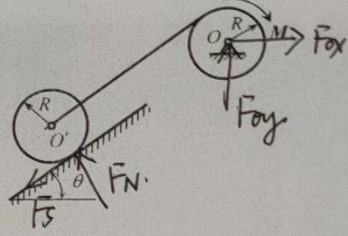
综-5、在图示机构中，沿斜面纯滚动的圆柱体 O' 和 O 鼓轮为均质物体，质量均为 m，半径均为 R。绳子不能伸缩，其质量略去不计。粗糙斜面的倾角为θ，不计滚阻力偶。如在鼓轮上作用一常力偶 M。求：（1）鼓轮的角加速度；（2）轴承的水平约束力。



$W_{12} = M\varphi - mg \cdot s \cdot \sin\theta$

$T = \frac{1}{2}\frac{1}{2}mR^2 \cdot \omega^2 + \frac{3}{4}m v_{O_1}^2 = \frac{1}{4}mR^2\omega^2 + \frac{3}{4}mR^2\omega^2$

$(\frac{M}{R} - mg\sin\theta) \cdot s = mR^2\omega^2$

∴ ~~对~~两边求导 $\therefore \alpha = \frac{M - mgR\sin\theta}{2mR^2}$

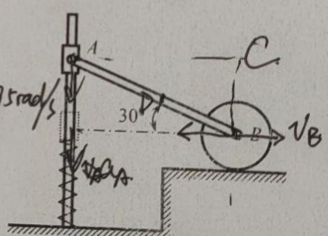
$F_N = \cancel{F\cos}\, mg\cos\theta$ $F_S \cdot R = \frac{1}{2}mR^2 \cdot \alpha'$ $\therefore F_S = \frac{1}{2}mR\alpha$

$\therefore F_{Ox} - F_S \cdot \cos\theta - mg\cos\theta \cdot \sin\theta = mR\alpha\cos\theta$

$\therefore F_{Ox} = mg\cos\theta\sin\theta + \frac{3}{4}\frac{M - mgR\sin\theta}{R}\cos\theta = \frac{3}{4}\frac{M}{R}\cos\theta - \frac{1}{4}mg\sin\theta\cos\theta$

综-6、均质杆 AB 质量为 4kg，长 l=600mm。均质圆盘质量为 6kg，半径 r=100mm。弹簧刚度为 k=2N/mm，不计套筒 A 及弹簧的质量。如连杆在图示位置被无初速度释放后，A 端沿光滑杆滑下，圆盘作纯滚动。求（1）当 AB 达到水平位置而接触弹簧时，圆盘与连杆的角速度；（2）弹簧的最大压缩量δ；（3）当 AB 达到水平位置时 B 点的加速度。

(1). B为~~水平时~~瞬心. $v_B = 0$ $\omega_B = 0$



$W_{12} = m_{AB}\, g\, \frac{l}{2} \cdot \frac{1}{2}$

$T_2 = \frac{1}{2} \cdot \frac{1}{3} m_{AB} l^2 \omega_{AB}^2$ $\therefore \omega_{AB} = \sqrt{\frac{3g}{2l}} = 4.95\,\text{rad/s}$

~~$\frac{1}{6}l^2\omega_{AB}^2 = \frac{1}{4}$~~

(2). $W = m_{AB}\, g\, (\frac{\delta}{2} + \frac{l}{4}) + \frac{1}{2}k(0 - \delta^2)$

$T_2 = 0$

$\therefore \delta = 87\,\text{mm}$

(3) $T = \frac{3}{4}m_B v_B^2 + \frac{1}{2}J_C\omega_{AB}^2 = \frac{3}{4}m_B v_B^2 + \frac{1}{2} \cdot (\frac{1}{12}m_{AB}l^2 + m_{AB} \cdot \frac{l^2}{4})(\frac{v_B}{l\sin\theta})^2$

$W = m_{AB}\, g\, (\frac{l}{4} - \frac{l}{2}\sin\theta)$

求导

$\dot\theta = \omega_{AB} = \frac{v_B}{l\sin\theta}$

$\therefore a_B = 14.7\,\text{m/s}^2$