5.2. $\omega r_2 = \omega_1 r_1$

$\alpha t = \omega_1$

$\therefore t = \dfrac{\omega r_2}{\alpha r_1}$

5.3. (1) $M = r \times F$

$\alpha = \dfrac{M}{J}$

$\cancel{J = \frac{1}{2} m r^2}$

$\therefore \alpha = 39.2 \text{ rad/s}^2$

(2) $\cancel{a_\tau = r\alpha}$ $\qquad \Delta E_k = F x = 490 \text{ J}$

$\cancel{\frac{1}{2} a_\tau t^2 = x}$

$\cancel{\alpha t = \omega - 0}$

$\cancel{\Delta E_k = \frac{1}{2} J \omega^2 - 0}$

$\cancel{\therefore \Delta E_k =}$ [illegible] $\cancel{490 \text{ J}}$

(3) $M = r \times F'$

$mg - F' = ma$

$a = r\alpha'$

$\alpha' = \dfrac{M}{J}$

$\therefore \alpha' = 21.78 \text{ rad/m}^2$ $\qquad$ (g取9.8 m/s^2)

5.4 $m_1g - T_1 = m_1 r_1 \alpha$

$T_2 - m_2 g = m_2 r_2 \alpha$

$r_1 T_1 - r_2 T_2 = J\alpha$

$a_1 = r_1\alpha$

$\therefore \alpha = \dfrac{r_1 m_1 g - r_2 m_2 g}{J + m_1 r_1^2 + m_2 r_2^2}$, $a_1 = \dfrac{r_1(r_1 m_1 g - r_2 m_2 g)}{J + m_1 r_1^2 + m_2 r_2^2}$

$T_1 = m_1 g - m_1 r_1 \dfrac{r_1 m_1 g - r_2 m_2 g}{J + m_1 r_1^2 + m_2 r_2^2}$

$T_2 = m_2 g + m_2 r_2 \dfrac{r_1 m_1 g - r_2 m_2 g}{J + m_1 r_1^2 + m_2 r_2^2}$

5.5 $mg - T = ma$

$a = R\alpha$

$RT = (J + J_0)\alpha$

$\cancel{Rmg - R^2 m\alpha = J+}$

$\therefore \alpha = \dfrac{Rmg}{R^2 m + J + J_0}$

$a = \dfrac{R^2 mg}{R^2 m + J + J_0}$ 为定值

$\therefore$ 匀加.

$\therefore h = \frac{1}{2} a t^2$.

$\therefore$ ~~[illegible]~~ $a = \dfrac{2h}{t}$

故 ~~[illegible]~~ $J = \dfrac{R^2 mg t^2}{2h} - R^2 m - J_0$

5.7. (1) $\boxed{\cancel{\int M dt = \int lF dt}}$

子弹 $\int F dt = m_1 v - m_1 v_0 = \frac{2}{3} m_1 v_0$

杆 $\int M dt = \int lF dt = l\int F dt = \frac{2}{3} l m_1 v_0$

$= J\omega = \frac{1}{3} m l^2 \times \omega$

$\therefore \omega = \frac{2m_1}{ml} v_0$

(2) $l m_1 v_0 = l m_1 v + \frac{1}{3} m l^2 \omega$

$\therefore \omega = \frac{2m_1 v_0}{ml}$

5.9. $J\omega_0 = J\omega_1 + R m_2 \omega_1 R$

$\cancel{\frac{1}{2} m_1 R^2 \omega}$ $\frac{1}{2} J\omega_1^2 + \frac{1}{2} m_2 (\omega_1 R)^2 = m_2 g h$

$\therefore h = \frac{m_1^2 \omega_0^2 R^2}{4 m_2 g (m_1 + 2m_2)}$

5.10. $Rm(v - \omega R) = \frac{1}{2} m_1 R^2 \omega$. 对任意时刻成立.

~~减~~一周后, $Rm(2\pi R - \theta R) = \frac{1}{2} m_1 R^2 \theta$

$\therefore \theta = \frac{4\pi m}{2m + m_1}$

人: $\varphi = 2\pi - \theta = \frac{2\pi m_1}{2m + m_1}$

5.11 (1) $\cancel{\frac{1}{2}J\omega_0^2+2\times\frac{1}{2}m_2(\omega_0 d) \ldots m_2(\omega_1\frac{l}{2})^2+\frac{1}{2}J\omega_1^2}$

$\cancel{\therefore \omega_1 = 6\ rad/s}$

(1) $\cancel{J\omega_0+2r m_2 d = J\omega_1+2r m_2\frac{l}{2}}$

$J\omega_0+2d m_2 \omega_0 d = J\omega_1+2\,\frac{1}{2}m_2\omega_1\frac{l}{2}$

$\therefore \omega_1 = 6\ rad/s$

(2) $\frac{1}{2}J\omega_0^2+2\times\frac{1}{2}m_2(\omega_0 d)^2 = \frac{1}{2}J\omega_1^2+2\times\frac{1}{2}m_2 v^2$

$\therefore v = 1.02\ m/s$

$v_\perp = \omega_1\times\frac{l}{2} = 0.6\ m/s.$

$\sin\theta = \frac{v_\perp}{v} = \frac{0.6}{1.02}$

$\therefore \theta = \arcsin\frac{0.6}{1.02} = 36^\circ$

5.13. $m_1 g\frac{l}{2} = \frac{1}{2}J\omega^2$

$J\omega = J\frac{v}{l} + l m_2 v$

$\mu m_2 g s = \frac{1}{2}m_2 v^2$

$\therefore s = \frac{3m_1^2 l}{2\mu(m_1+3m_2)^2}$

5.12. (1) $J\omega_0 = J\omega_1 + RmV$

$V = \omega_1 R$

$\therefore \omega_1 = \frac{1}{3}\omega_0$, $V = \omega_1 R = \frac{1}{3}\omega_0 R$

(2) $T - f = ma$

$f = \mu mg$

$a = R\alpha$

$-TR = J\alpha$

$\therefore T = \frac{1}{3}\mu mg$.

5.13 中点B: (1) $J\omega_0 = J\omega_1 + rm\omega_1 R$

$\therefore \omega_1 = \frac{1}{3}\omega_0$

(2) $\frac{1}{2}J\omega_0^2 + mgR = \frac{1}{2}J\omega_1^2 + \frac{1}{2}m \overset{v^2}{\cancel{(v^2+\omega_1^2R^2)}}$

$\therefore v = \sqrt{\frac{4}{9}R^2\omega_0^2 + 2gR}$

底部C: (1) $J\omega_0 = J\omega_2 + 0$

$\therefore \omega_2 = \omega_0$

(2) $\frac{1}{2}J\omega_0^2 + mg2R = \frac{1}{2}J\omega_0^2 + \frac{1}{2}mv^2$

$\therefore v = 2\sqrt{gR}$

5.17. (1) $-\hat{i}$

(2) $lm_A g - lm_B g = L\omega$.

$m_B = \frac{lm_A g - L\omega}{lg}$

补1、质量为m的汽车在水平路面上紧急刹车，前后轮均停止转动。设两轮的间距为L，与地面间的摩擦系数为μ，汽车质心离地面的高度为h，与前轮轴的水平距离为*l*，求前后轮对地面的压力。

解：以质心为参考点

$N_1 L = f_1 h + f_2 h + N_2(L-l)$

又 $N_1 + N_2 = mg$

且 $f_1 = \mu N_1$

$f_2 = \mu N_2$

$\therefore N_1 = \frac{mg(L-l)+\mu mgh}{L}$

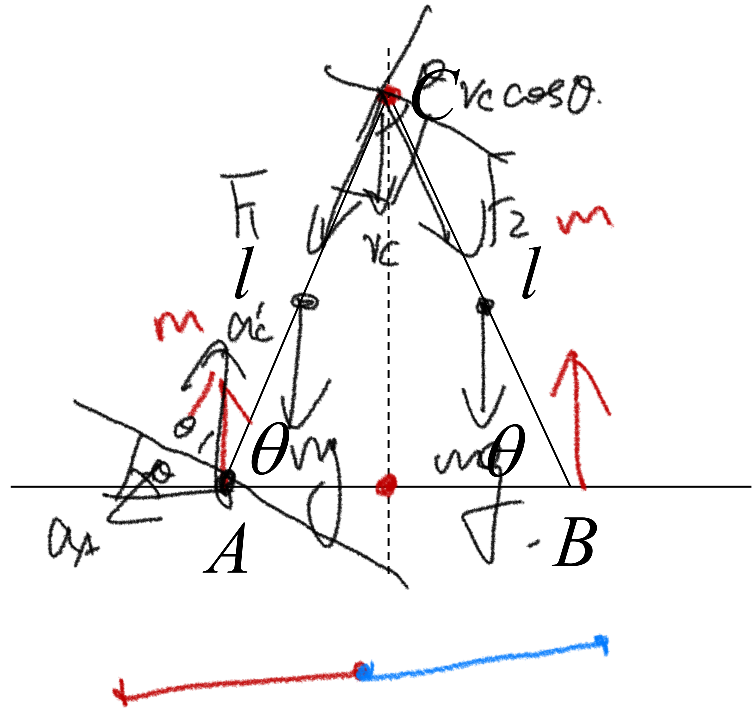
$N_2 = \frac{mgl - \mu mgh}{L}$

补2、如图所示，两根质量均为m、长度均为l的相同匀质细杆AC与CB，两杆 的C端用一光滑的铰链相连。将两杆分开一定角度，让A、B端与光滑地面接触，并使两杆均在竖直平面内。开始时两杆与地面间的夹角均为θ。现无初速地释放两杆，问两杆着地时C点的速度。

$mg\frac{l}{2}\sin\theta=\frac{1}{2}J\omega^2$

$v_C=l\omega$

$\therefore v_C=\sqrt{3gl\sin\theta}$



补3、一面粗糙另一面光滑的木板，质量为M，将光滑的一面放在水平桌面上，木板上放一个质量为m的球。如果板沿其长度方向突然有一速度V，球与粗糙面间的动摩擦因数为 μ ，问此球经过多少时间后开始滚动而不滑动。

$f = \mu mg$

$f = Ma = m a_c$

$V_m = V - at$

$a_{转} = r\alpha$

不滑：$a_c t + a_{转} t = V_m$

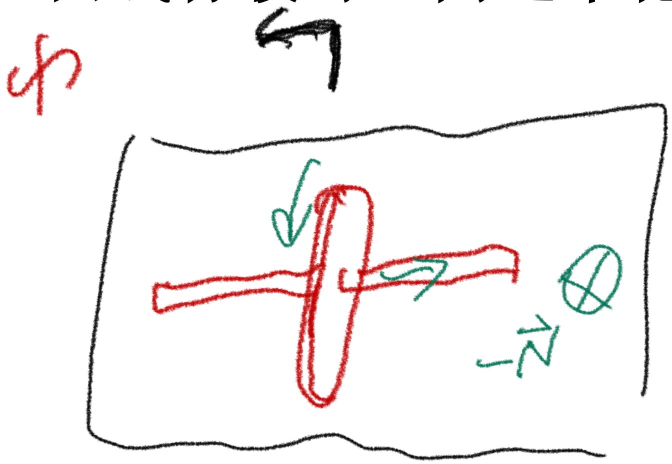
$fr = J\alpha$

$\therefore t = \dfrac{2MV}{(2m+7M)\mu g}$

补4、为了避免高速行驶的汽车在转弯时容易发生的翻车现象，可在车上安装一高速自转的大飞轮。

（1）试问，飞轮轴应安装在什么方向上（假设汽车从上向下看逆时针转弯）？飞轮应沿什么方向转动？

（2）设汽车质量为M，其行驶速度为v，飞轮是质量为m、半径为R的圆盘，汽车（包括飞轮）的质心距地面高度为h，为使汽车绕一曲线行驶时，两边车轮的负荷相等，求飞轮的转数。

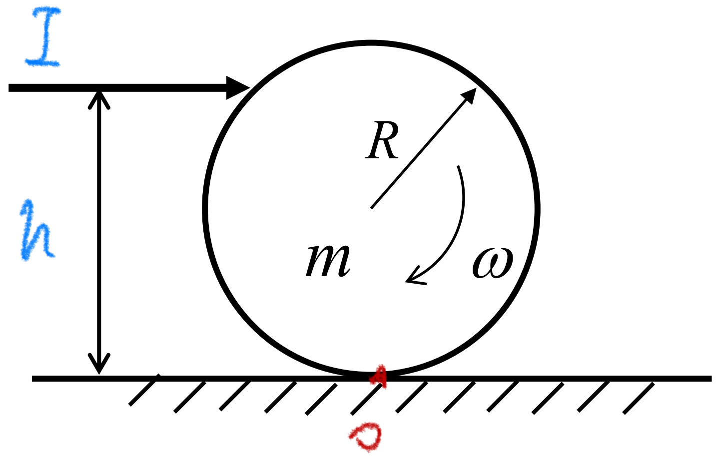


俯视图

(2) $(m+M)\frac{v^2}{r}h=\left|\frac{d\vec{L}}{dt}\right|=L\Omega=\frac{1}{2}mR^2\omega\frac{v}{r}$

$\therefore\ \omega=\frac{2(m+M)vh}{mR^2}$

补5、如图所示，将一水平方向的冲量I作用在质量为m、半径为R的原先静止的匀质小球上，作用点位于球心的上方，距地面的高度为h，作用线位于过球心而平行于纸面的平面内。试分析小球以后的运动情况，并求出小球作纯滚动时的角速度。



解：先发生有滑动的滚动，后发生无滑滚动。

以地面O点为参考点。

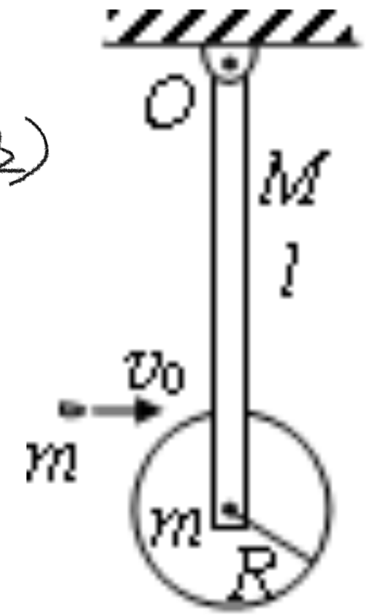
$Ih = Rmv_c + J_c\omega_f$

无滑：

$v_c = R\omega_f$

$\therefore \omega_f = \dfrac{2Ih}{3mR^2}$

1、如图所示，半径为R、质量为m的均质圆盘通过无摩擦的轴承装于一长为*l*、质量为M均质细杆的一端。现有一质量也为m，大小可忽略的子弹以速度v_0水平入射到圆盘的顶端并嵌入，求子弹射入圆盘后瞬间，细杆绕光滑O轴转动的角速度ω_1。



O点:

$$mv_0(L-R)=\frac{1}{3}ML^2\omega_1-\frac{1}{2}mR^2\omega_2+Lm\omega_1L+(L-R)m(L\omega_1+R\omega_2)$$

圆盘中心:

$$mv_0R=\frac{1}{2}mR^2\omega_2+Rm(\omega_2R+\omega_1L)$$

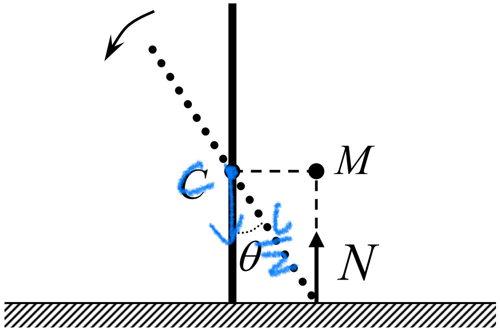
$$\omega_1=\frac{mv_0l}{Ml^2+4l^2m}=\frac{mv_0}{Ml+4ml}$$

2、匀质细杆直立在光滑地面上，因不稳定而倾倒。在细杆全部着地前，它的下端是否会跳离地面？

$v_c = \omega\left(\frac{l}{2}\sin\theta\right)$

$mg\frac{l}{2}(1-\cos\theta) = \frac{1}{2}mv_c^2 + \frac{1}{2}J\omega^2.$

$\therefore v_c = \sqrt{\frac{3gl(1-\cos\theta)\sin^2\theta}{1+3\sin^2\theta}}.$



求t求导．得 $\omega = \frac{2v_c}{l\sin\theta}$

$a_c = \frac{3g(\sin^2\theta + 3\sin^4\theta + 2\cos\theta - 2\cos^3\theta)}{(1+3\sin^2\theta)^2}$

$N = mg - ma_c = \frac{3\cos^2\theta - 6\cos\theta + 4}{(1+3\sin^2\theta)^2}mg.$

易得 $3\cos^2\theta - 6\cos\theta + 4 = 3(\cos\theta - 1)^2 + 1 > 0.$

故 $N>0$. 不离地.