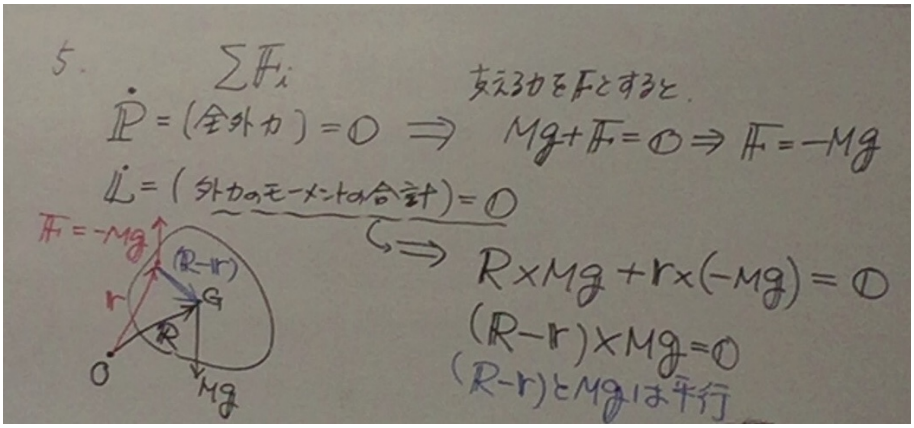
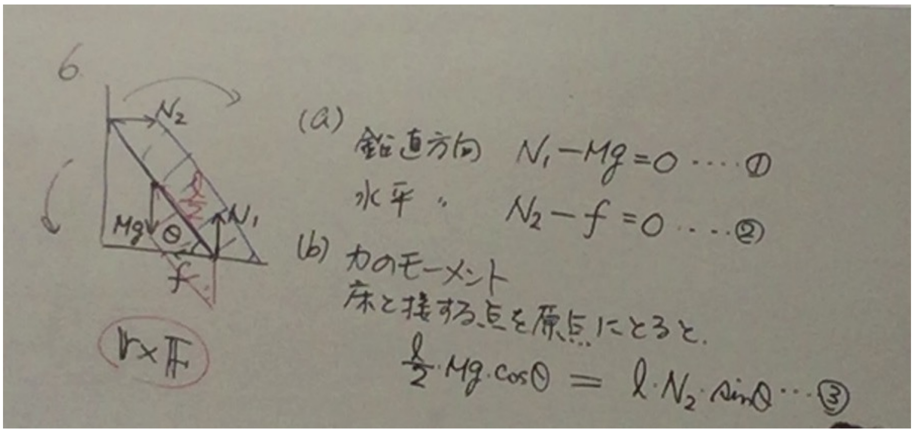
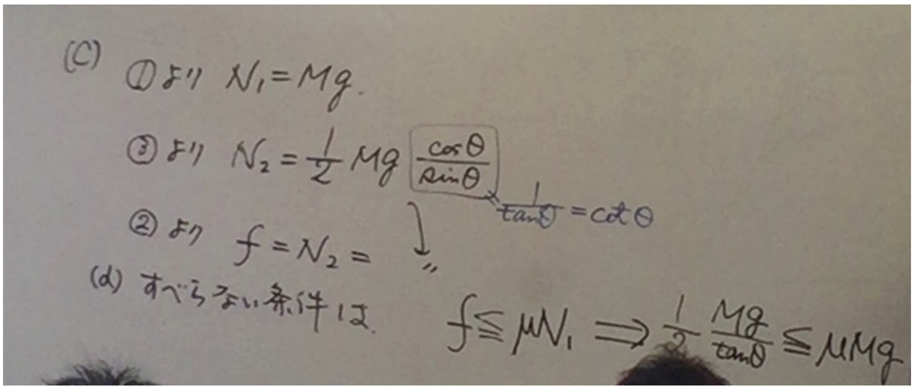
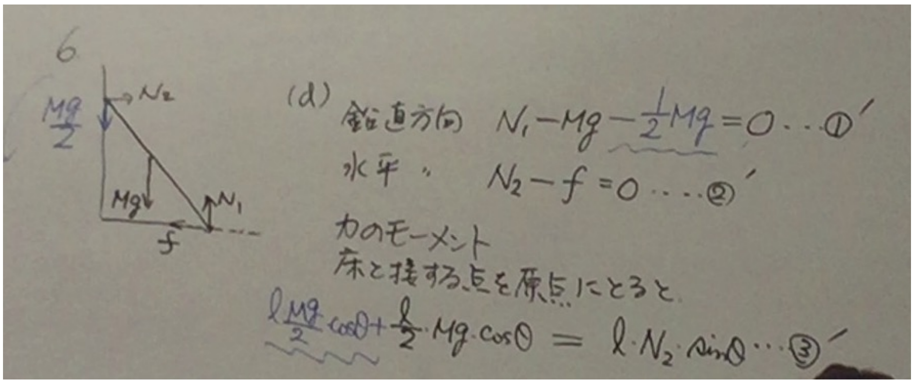
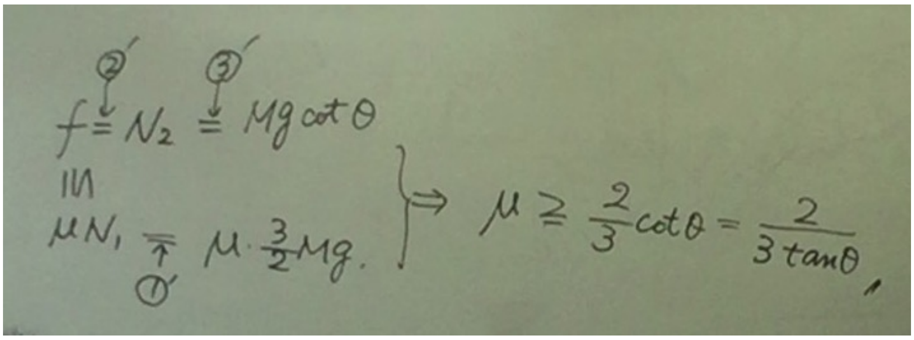
1 Prblm2


5.
$\sum F_i$
支える力をFとすると
$\dot{P}$ = (全外力) = 0 ⇒ $Mg + F = 0$ ⇒ $F = -Mg$
$\dot{L}$ = (外力のモーメントの合計) = 0
⇒ $R \times Mg + r \times (-Mg) = 0$
$(R-r) \times Mg = 0$
$(R-r)$とMgは平行
$F = -Mg$
$(R-r)$
G
r
R
O
Mg


6.
N_2
Mg
θ
N_1
f
$\frac{l}{2}$
$r \times F$
(a) 鉛直方向 $N_1 - Mg = 0$ ····①
水平 : $N_2 - f = 0$ ····②
(b) 力のモーメント
床と接する点を原点にとると、
$\frac{l}{2} \cdot Mg \cdot \cos\theta = l \cdot N_2 \cdot \sin\theta$ ···③

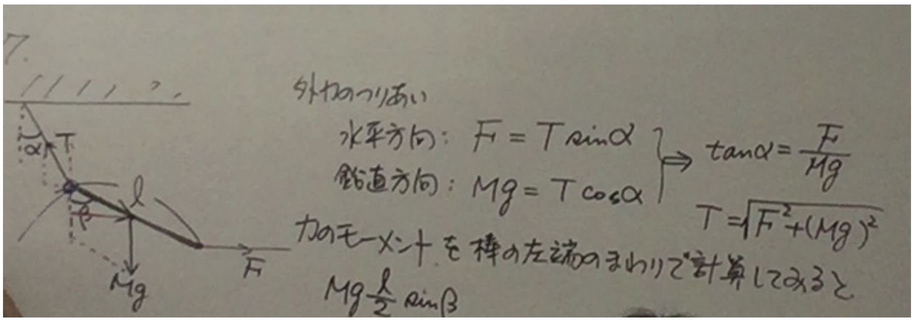

(c) ①より $N_1 = Mg$.
③より $N_2 = \frac{1}{2} Mg \boxed{\frac{\cos\theta}{\sin\theta}}$
$\frac{1}{\tan\theta} = \cot\theta$
②より $f = N_2 =$ 〃
(d) すべらない条件は $f \leqq \mu N_1 \Rightarrow \frac{1}{2}\frac{Mg}{\tan\theta} \leqq \mu Mg$


6
$\frac{Mg}{2}$
N_2
Mg
N_1
f
(d) 鉛直方向 $N_1 - Mg - \frac{1}{2}Mg = 0$ ···①'
水平 : $N_2 - f = 0$ ···②'
力のモーメント
床と接する点を原点にとると、
$l\frac{Mg}{2}\cos\theta + \frac{l}{2} \cdot Mg \cdot \cos\theta = l \cdot N_2 \cdot \sin\theta$ ···③'



$$f \overset{②'}{=} N_2 \overset{③'}{=} Mg\cot\theta$$

$$\mu N_1 \overset{①'}{=} \mu\cdot\frac{3}{2}Mg \quad \Rightarrow \quad \mu \geq \frac{2}{3}\cot\theta = \frac{2}{3\tan\theta}$$



外力のつりあい

水平方向: $F = T\sin\alpha$

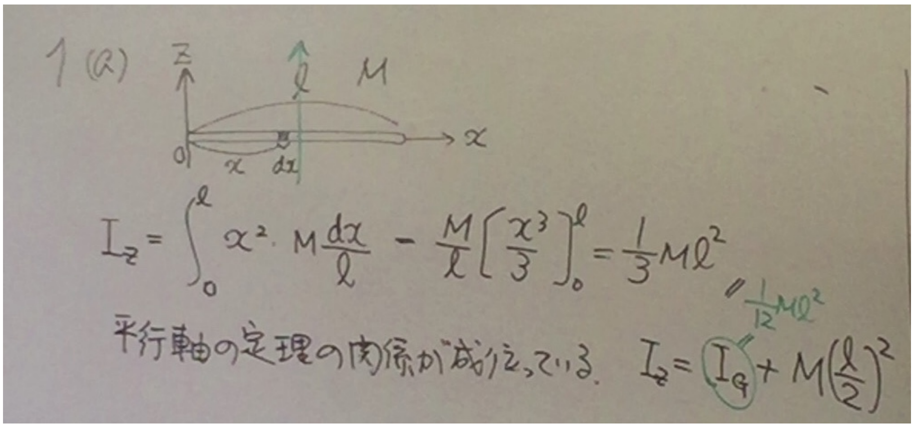
鉛直方向: $Mg = T\cos\alpha$

$\Rightarrow \tan\alpha = \frac{F}{Mg}$, $T = \sqrt{F^2 + (Mg)^2}$

力のモーメントを棒の左端のまわりで計算してみると

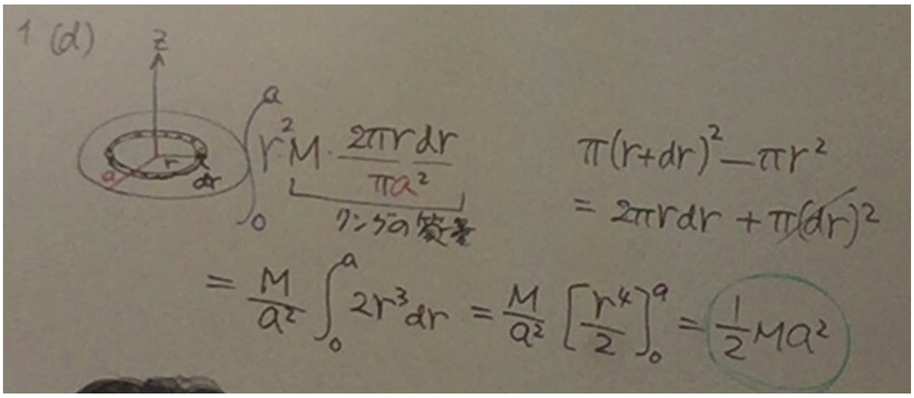
$Mg\frac{l}{2}\sin\beta$

2 Prblm3



$$I_z = \int_0^l x^2\cdot M\frac{dx}{l} = \frac{M}{l}\left[\frac{x^3}{3}\right]_0^l = \frac{1}{3}Ml^2$$

平行軸の定理の関係が成り立っている。 $I_z = \underset{\frac{1}{12}Ml^2}{I_G} + M\left(\frac{l}{2}\right)^2$

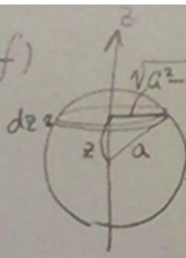


$$\int_0^a r^2 \underbrace{M\cdot\frac{2\pi r\,dr}{\pi a^2}}_{\text{リングの質量}}$$

$$\pi(r+dr)^2 - \pi r^2 = 2\pi r\,dr + \cancel{\pi(dr)^2}$$

$$= \frac{M}{a^2}\int_0^a 2r^3 dr = \frac{M}{a^2}\left[\frac{r^4}{2}\right]_0^a = \frac{1}{2}Ma^2$$

1 (f)



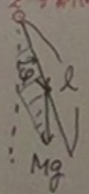
$$\tfrac{1}{2}Ma^2$$

$$I_z = \int_{-a}^{a} \frac{1}{2}(a^2-z^2) \cdot M \frac{\pi(a^2-z^2)\,dz}{\frac{4\pi}{3}a^3}$$

$$= \frac{3M}{8a^3}\int_{-a}^{a}(a^2-z^2)^2\,dz = \cdots\cdots = \frac{2}{5}Ma^2$$

3

(a)



外力のモーメントのz成分N_zは

$$N_z = - \frac{l}{2}Mg\sin\varphi \qquad \mathbf{r}\times\mathbf{F}$$

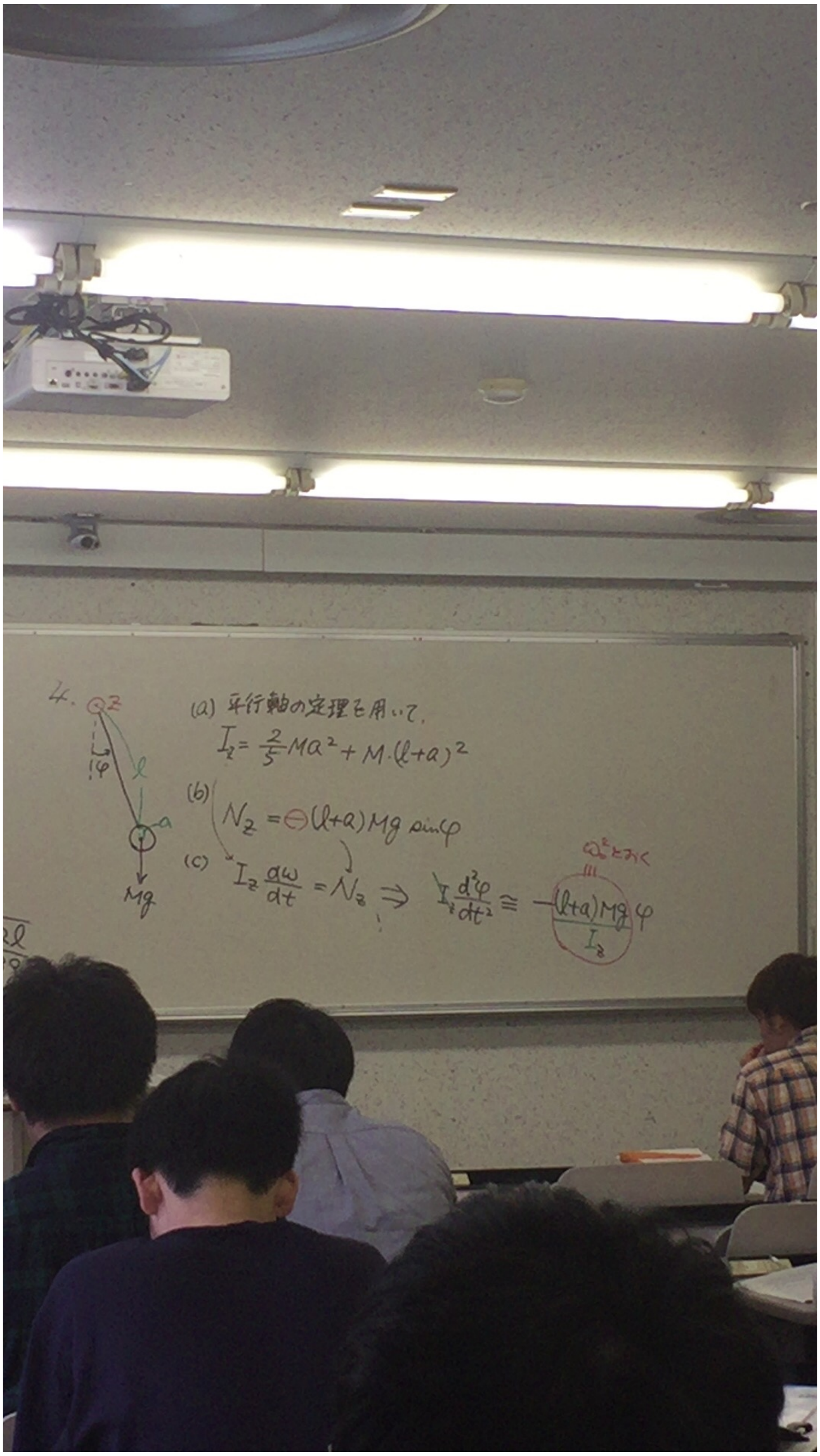
(b) (8.5) $I_z \frac{d\omega}{dt} = N_z$ より $\boxed{\frac{1}{3}Ml^2\frac{d^2\varphi}{dt^2} = -\frac{l}{2}Mg\sin\varphi}$

(c) $|\varphi| \ll 1$ のとき $\sin\varphi \cong \varphi$ なので

$$\frac{1}{3}Ml^2\frac{d^2\varphi}{dt^2} \cong -\frac{l}{2}Mg\,\varphi$$

$$\frac{d^2\varphi}{dt^2} = -\underbrace{\boxed{\frac{3g}{2l}}}_{\omega_0^2\text{とおく}}\varphi$$

φの一般解は $\varphi = A\cos(\omega_0 t+\alpha) \Rightarrow$ 周期$T = \frac{2\pi}{\omega_0} = 2\pi\sqrt{\frac{2l}{3g}}$


4.
(a) 平行軸の定理を用いて、
$I_z = \frac{2}{5}Ma^2 + M\cdot(l+a)^2$
(b) $N_z = -(l+a)Mg\sin\varphi$
(c) $I_z\frac{d\omega}{dt} = N_z \Rightarrow I_z\frac{d^2\varphi}{dt^2} \cong -\frac{(l+a)Mg}{I_z}\varphi$
ω_0^2とおく
Mg