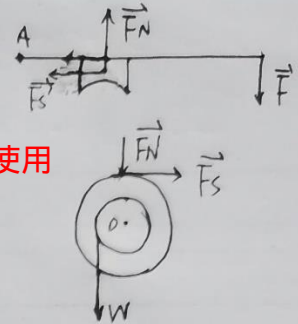


4-1解：对杆 $\Sigma M_A = 0$ $FL = F_N \cdot a$
 $\Sigma M_O = 0, F_S R - W r = 0$ $F_S \leq f_s \cdot F_N$

得 $F \geq 300 N$

故制动最小力 F 为 $300 N$

b未使用



4-2解：最大时 $f_s F_{\max} \sin \theta + P - F_{\max} \cos \theta = 0$ 得 $F_{\max} = 134.95 N$

最小时 $f_s F_{\min} \sin \theta + F_{\min} \cos \theta - P = 0$ 得 $F_{\min} = 100.91 N$

故保持静止时力 F 大小范围为 $100.91 N \leq F \leq 134.95 N$

4-3解：假设静止，沿杆方向

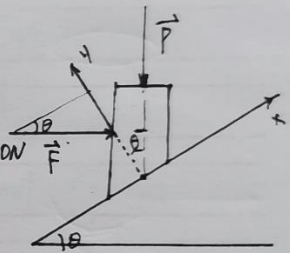
$F_N - F \cdot \sin \theta - P \cos \theta = 0$

沿 x 轴 $F \cos \theta + F_S - P \sin \theta = 0$ 得 $F_S = -9.8 N, F_N = 583.0 N$

$|F_S| < F_{\max} = f_s \cdot F_N = 233.2 N$

故物体静止，摩擦力大小为 $9.8 N$

方向？

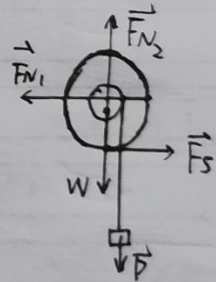


4-4解：受力如图，当物体A取最大重量时， F_S 达到最大 F_{\max}

$\Sigma F_y = 0$ $F_{N2} - P - W = 0 \Rightarrow F_{N2} = 500 N + P$

$\Sigma M_O = 0$ $F_S \cdot R - P \cdot r = 0$ 且 $F_S = F_{\max} = F \cdot F_{N2}$

联立得 $P = 500 N$ 即A最大重为 $500 N$



4-5解： $\Sigma F_x = 0$ 得 $F_{N1} - F_{N2} = 0$ 即 $F_{N1} = F_{N2}$

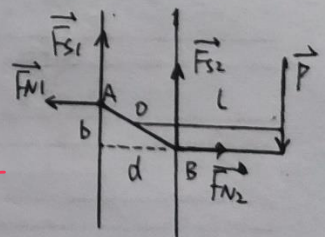
知当 l 为最小距离时，恰为临界平衡条件

$\Sigma F_y = 0$ $F_{S1} + F_{S2} - P = 0$ $\Sigma M_O = 0$

即 $F_{N1} \cdot \frac{b}{2} + F_{N2} \cdot \frac{b}{2} + F_{S2} \cdot \frac{d}{2} - F_{S1} \cdot \frac{d}{2} - P \cdot l = 0$

且 $F_{S1} = f_s F_{N1}, F_{S2} = f_s F_{N2}$

得 $l = 0.125 m$ 故 l 最小应为 $0.125 m$



4-6 解: 知 GCE 为二力杆

对石砖 $F_{N1} = F_{N2}$ $F_{S2} + F_{S1} - P = 0$

$$F_{S2} = f_s \cdot F_{N2}$$

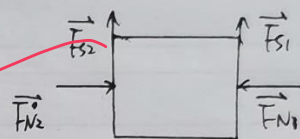
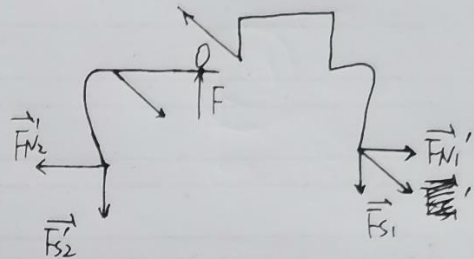
由二力杆 $\frac{F_{S1}}{F_{N1}} = \frac{b_0}{(95+95+30) \times 10^{-3} \text{m}}$

对整体 ~~解~~ 对石砖 $\Sigma M_O = 0$ (O 为 F 作用点)

$$F_{S2} \cdot (30 + \frac{95}{2}) - F_{S1} \cdot (30 + 95) = 0 \text{ 即 } F_{S1} = F_{S2}$$

$$\text{得 } b_0 = 0.11 \text{m} \text{ 知 } b \leq 0.11 \text{m}$$

故若使石砖夹起, $b \leq 0.11 \text{m}$



4-7 解 对球分析 $\Sigma M_O = 0$ $\Sigma F_y = 0$

$$F_{S1} = F_{S2} = \frac{W}{2} = 200 \text{N}$$

$$F_{S1} \leq f_s F_{N1}, F_{S2} = f_s F_{N2}, F_{N1} = F_{N2}$$

$$\text{得 } F_{N2} \geq 100 \text{N} \quad (1)$$

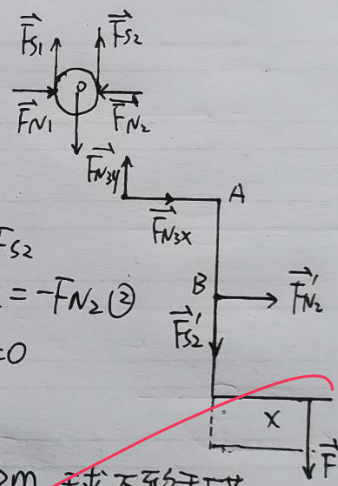
对折杆分析 $\Sigma F_y = 0$ $F_{N3y} - F_{S2}' - F = 0, F_{S2}' = F_{S2}$

$$\text{得 } F_{N3y} = 700 \text{N}; \Sigma F_x = 0 \quad F_{N3x} = -F_{N2}' = -F_{N2} \quad (2)$$

$$\Sigma M_B(F_i) = 0 \quad X \cdot F + 200 F_{N3y} + F_{N3x} \cdot 200 = 0$$

$$\text{故 } -F_{N3x} = \frac{F}{200} \Sigma X + 700 \quad (3)$$

联立 (1) (2) (3) 得 $X \geq 120 \text{mm}$ 故 $X \geq 0.12 \text{m}$ 球不致于下落



4-8 解: 知绳中张力为 P_2

$$\text{水平 } \Sigma F_x = 0 \quad P_2 \sin \theta - F_s = 0 \text{ 得 } F_s = P_2 \sin \theta$$

$$\Sigma F_y = 0 \quad F_N + P_2 \cos \theta - P_1 = 0$$

$$\text{得 } F_N = P_1 - P_2 \cos \theta$$

$$\Sigma M_O = 0 \text{ 得 } M + P_2 \cdot r - F_s \cdot R = 0$$

$$\text{得 } M = P_2 \sin \theta \cdot R - P_2 r$$

故滚动摩擦阻力偶矩为 $P_2 R \sin \theta - P_2 r$, 滑动摩擦力为 $P_2 \sin \theta$

法向反作用力为 $P_1 - P_2 \cos \theta$

