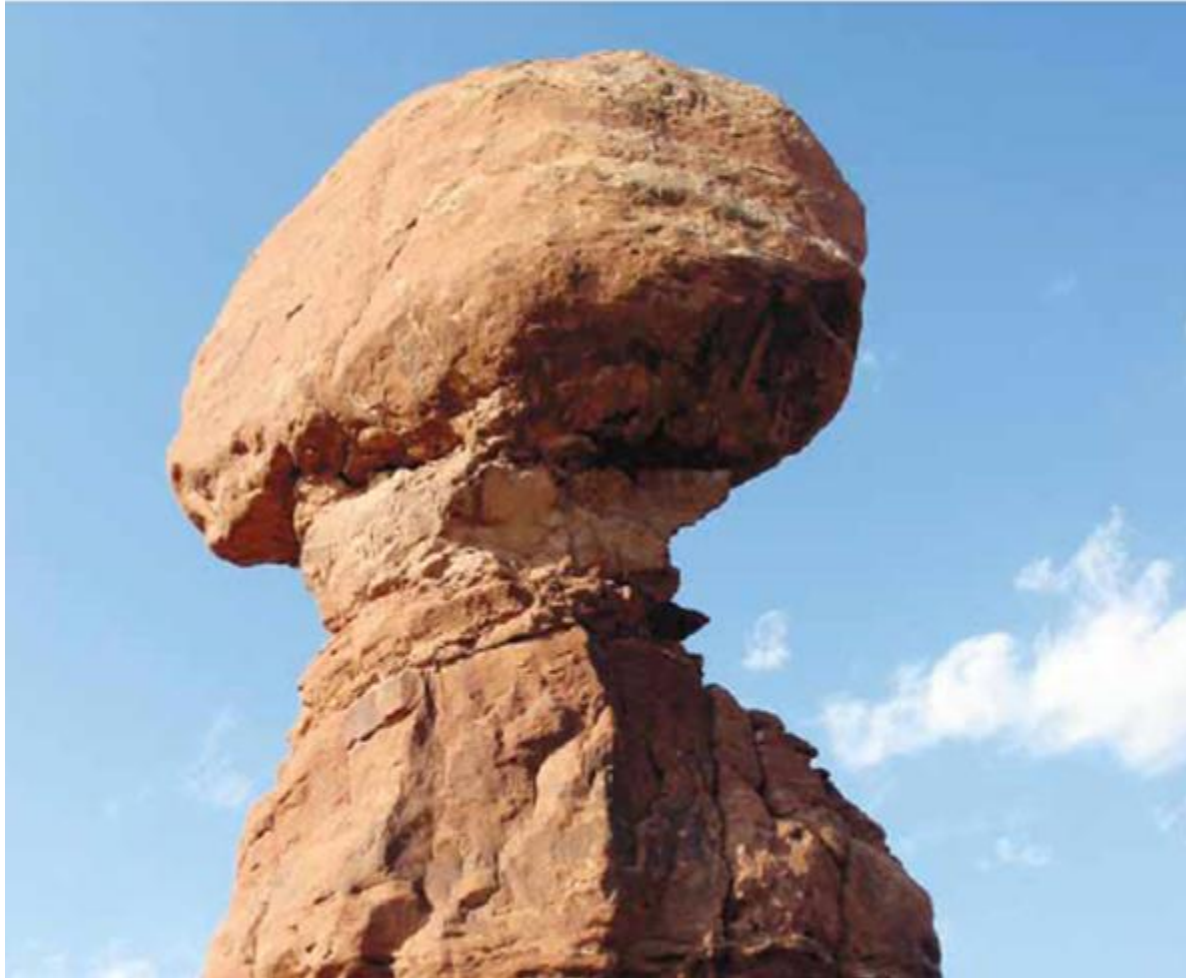
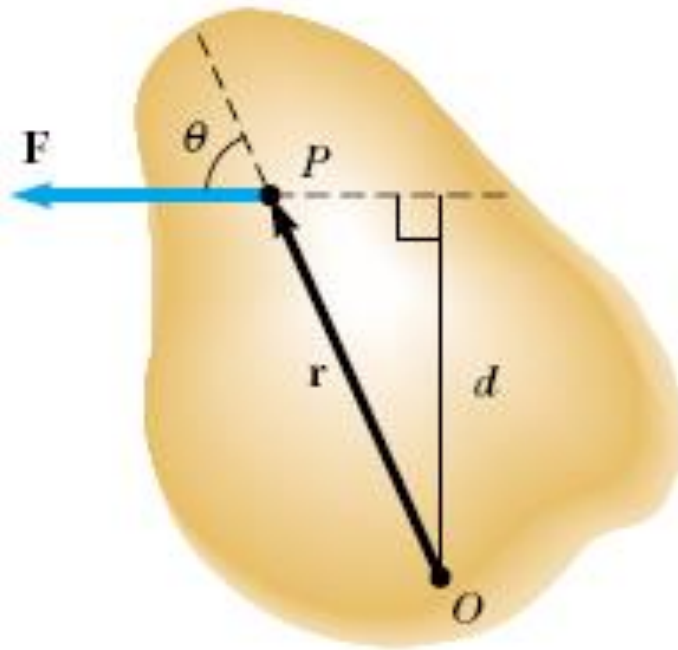


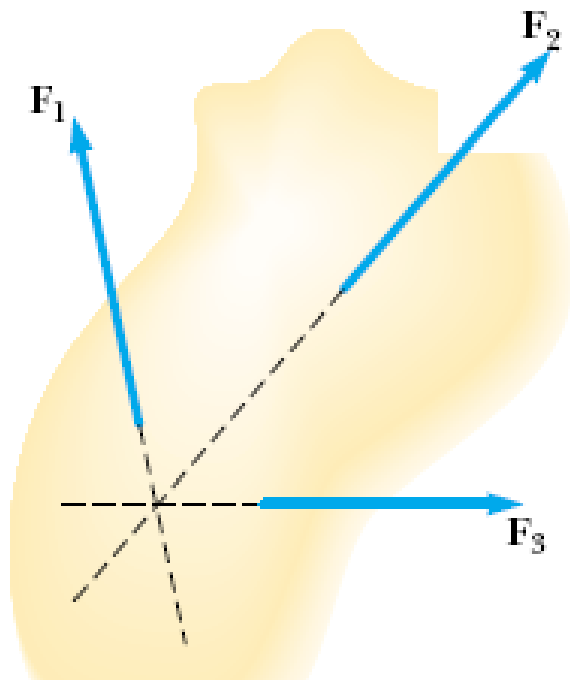
Bölüm 9 Statik denge ve elastiklik



Denge şartları



$$\boldsymbol{\tau} = \mathbf{r} \times \mathbf{F}$$



$$\sum \mathbf{F} = 0$$

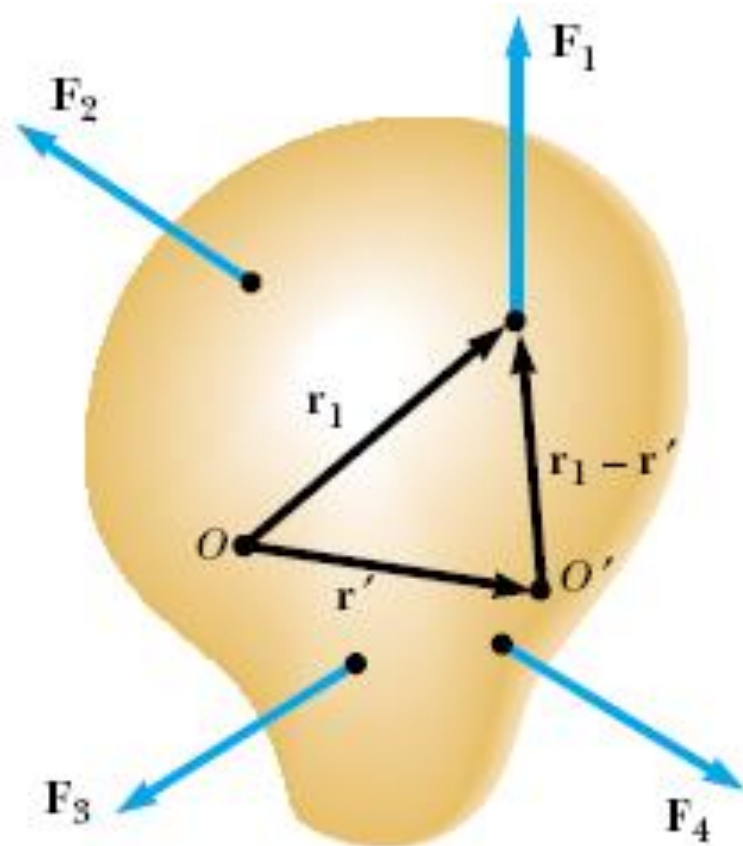
$$\sum \mathbf{F} = \mathbf{F}_1 + \mathbf{F}_2 + \mathbf{F}_3 + \cdots = 0$$

$$\sum F_x = 0$$

$$\sum F_y = 0$$

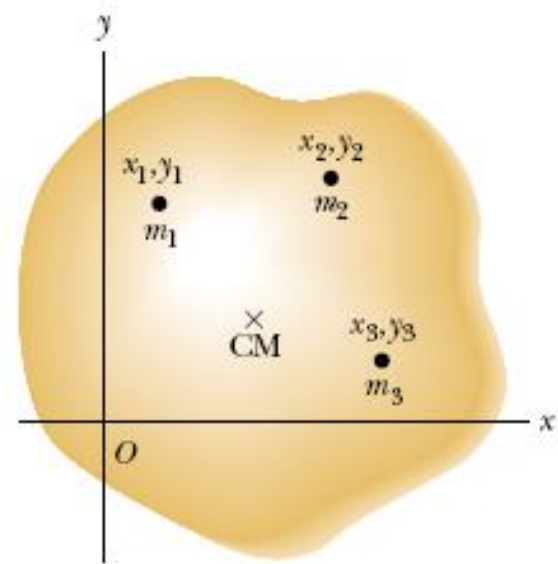
$$\sum \tau = 0$$

$$\sum \tau_O = \mathbf{r}_1 \times \mathbf{F}_1 + \mathbf{r}_2 \times \mathbf{F}_2 + \mathbf{r}_3 \times \mathbf{F}_3 + \cdots$$

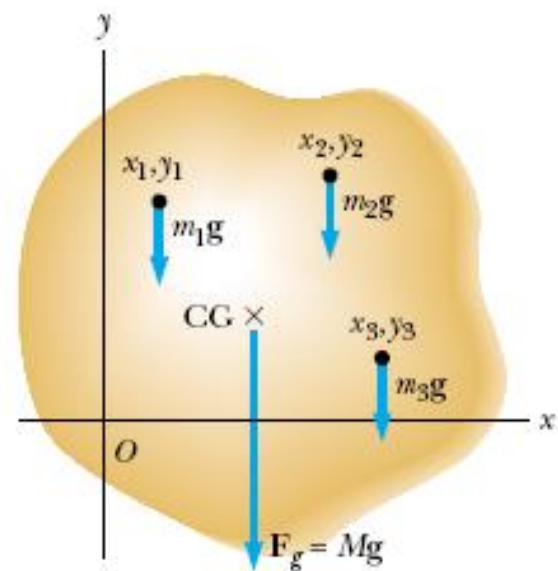


$$\begin{aligned}\sum \tau_{O'} &= (\mathbf{r}_1 - \mathbf{r}') \times \mathbf{F}_1 + (\mathbf{r}_2 - \mathbf{r}') \times \mathbf{F}_2 + (\mathbf{r}_3 - \mathbf{r}') \times (\mathbf{F}_3 + \cdots \\ &= \mathbf{r}_1 \times \mathbf{F}_1 + \mathbf{r}_2 \times \mathbf{F}_2 + \mathbf{r}_3 \times \mathbf{F}_3 + \cdots - \mathbf{r}' \times (\mathbf{F}_1 + \mathbf{F}_2 + \mathbf{F}_3 + \cdots)\end{aligned}$$

$$x_{\text{CM}} = \frac{m_1 x_1 + m_2 x_2 + m_3 x_3 + \cdots}{m_1 + m_2 + m_3 + \cdots} = \frac{\sum_i m_i x_i}{\sum_i m_i}$$



$$(m_1 g_1 + m_2 g_2 + m_3 g_3 + \cdots) x_{\text{CG}} = m_1 g_1 x_1 + m_2 g_2 x_2 + m_3 g_3 x_3 + \cdots$$



Örnek : Şekildeki sistem dengede ise d mesafesini hesaplayınız

$$\Sigma F_y = 0$$

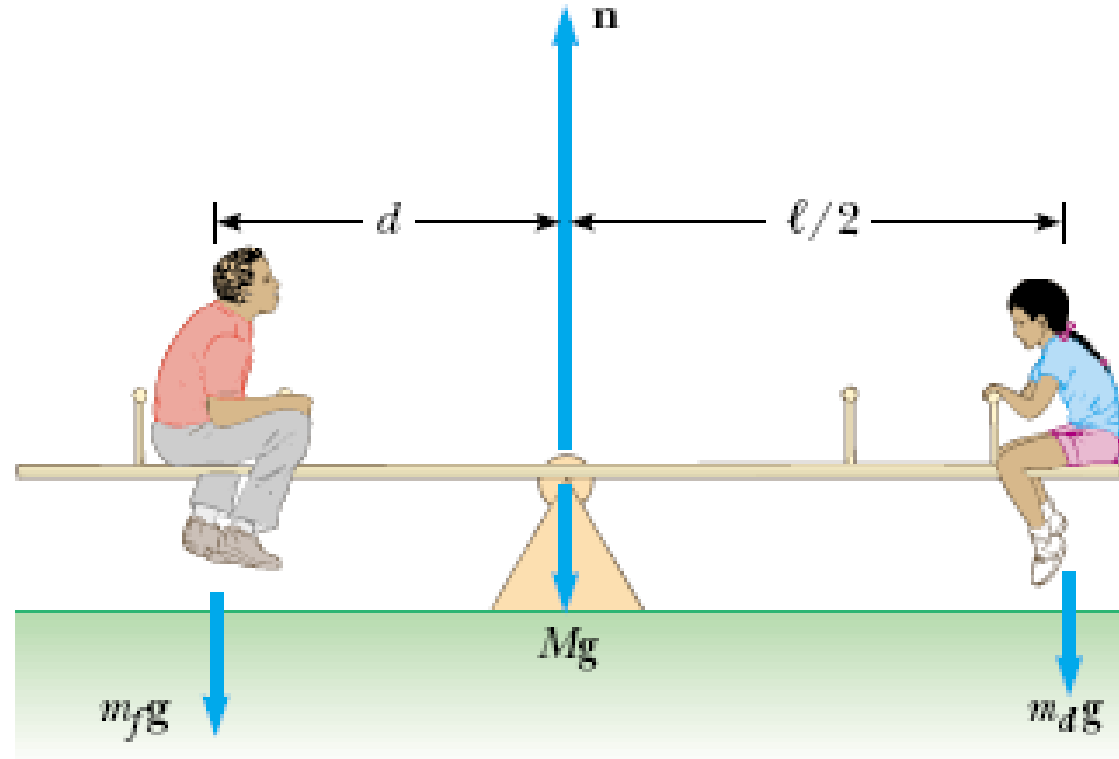
$$n - m_f g - m_d g - Mg = 0$$

$$n = m_f g + m_d g + Mg$$

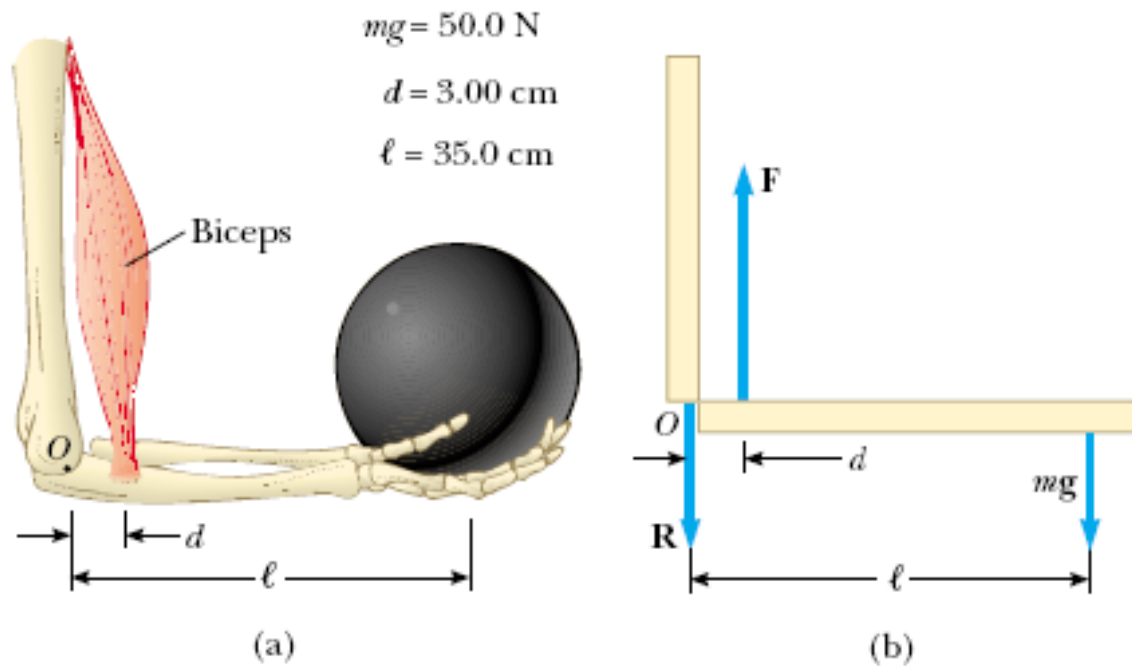
$$\Sigma \tau = 0$$

$$(m_f g)(d) - (m_d g) \frac{\ell}{2} = 0$$

$$d = \left(\frac{m_d}{m_f} \right) \frac{1}{2} \ell$$



Örnek : Şekildeki gülleyi dengede tutan F kuvvetini hesapayınız.

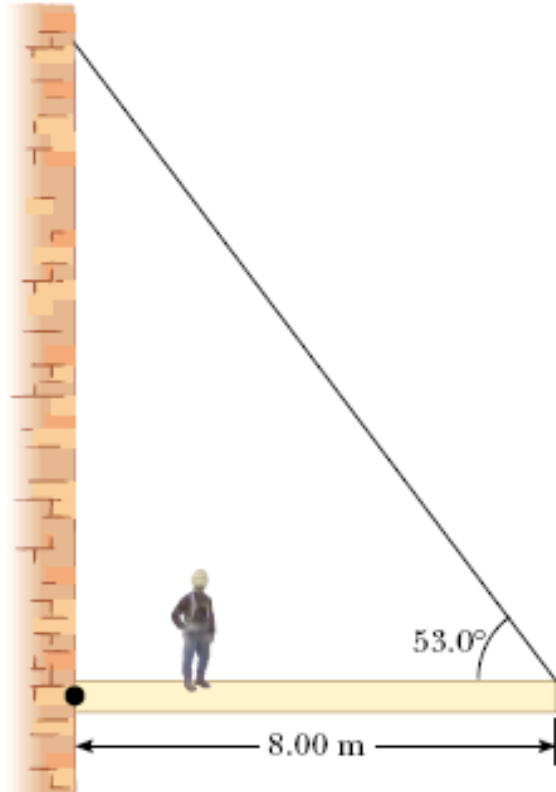


$$\sum \tau = Fd - mg\ell = 0$$

$$F(3.00 \text{ cm}) - (50.0 \text{ N})(35.0 \text{ cm}) = 0$$

$$\sum F_y = F - R - 50.0 \text{ N} = 0$$

$$F = 583 \text{ N}$$



$$\sum F_x = R \cos \theta - T \cos 53.0^\circ = 0$$

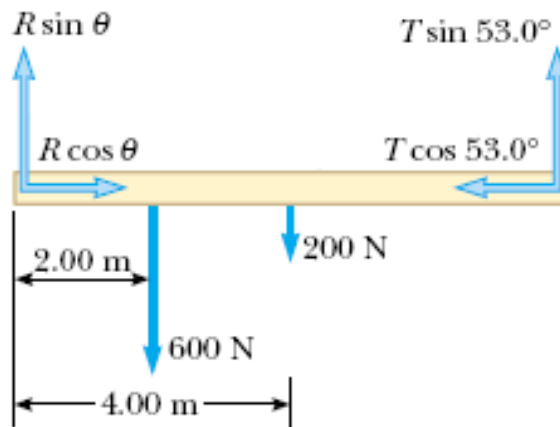
$$\sum F_y = R \sin \theta + T \sin 53.0^\circ - 600 \text{ N} - 200 \text{ N} = 0$$

$$\begin{aligned} \sum \tau &= (T \sin 53.0^\circ)(8.00 \text{ m}) - (600 \text{ N})(2.00 \text{ m}) \\ &\quad - (200 \text{ N})(4.00 \text{ m}) = 0 \end{aligned}$$

$$T = 313 \text{ N}$$

$$R \cos \theta = 188 \text{ N}$$

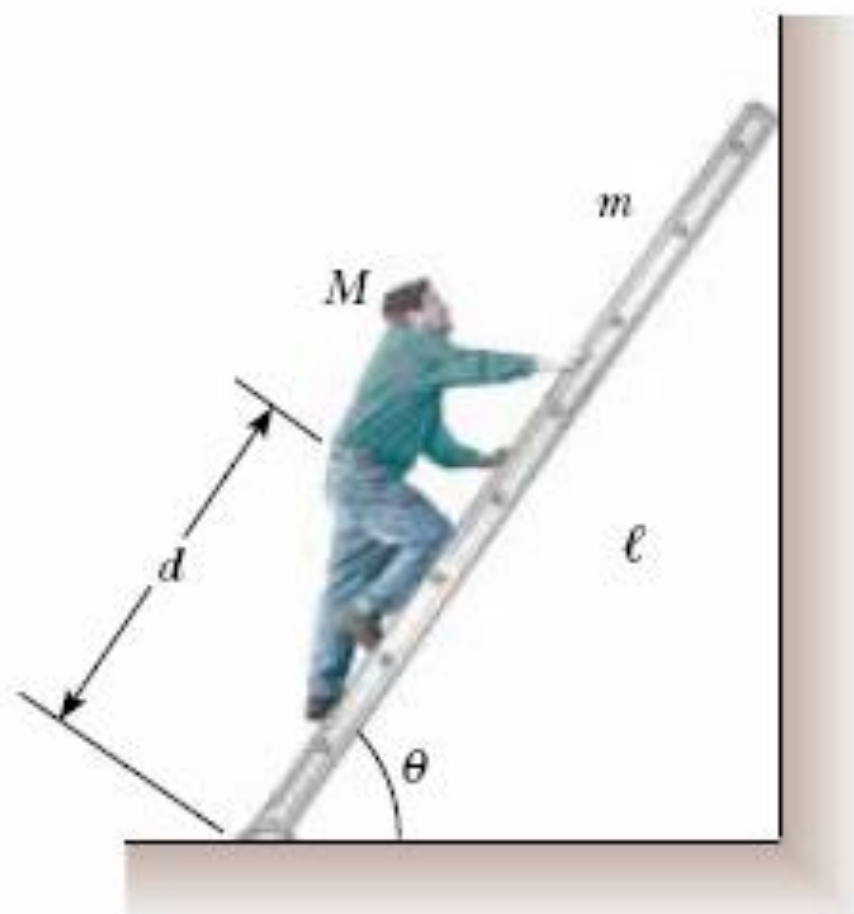
$$R \sin \theta = 550 \text{ N}$$



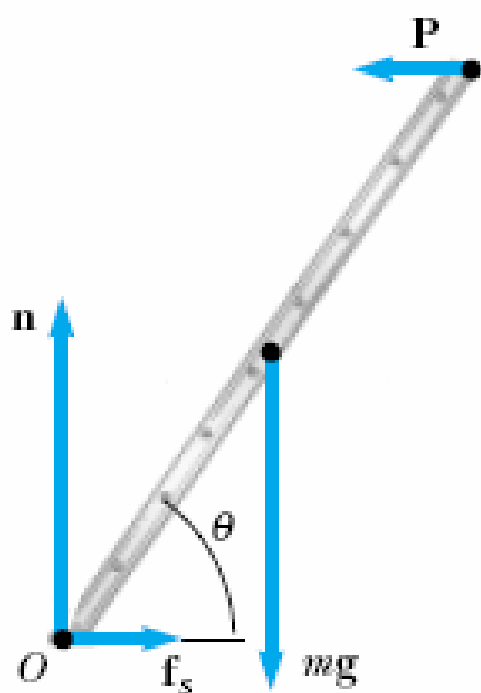
$$\tan \theta = \frac{550 \text{ N}}{188 \text{ N}} = 2.93 \quad \theta = 71.1^\circ$$

$$R = \frac{188 \text{ N}}{\cos \theta} = \frac{188 \text{ N}}{\cos 71.1^\circ} = 580 \text{ N}$$

Örnek : Kişini olmadığı ve olduğu durum için merdiven kaymaması için en küçük açı ne olmalıdır.



$$\mu_s = 0.40$$



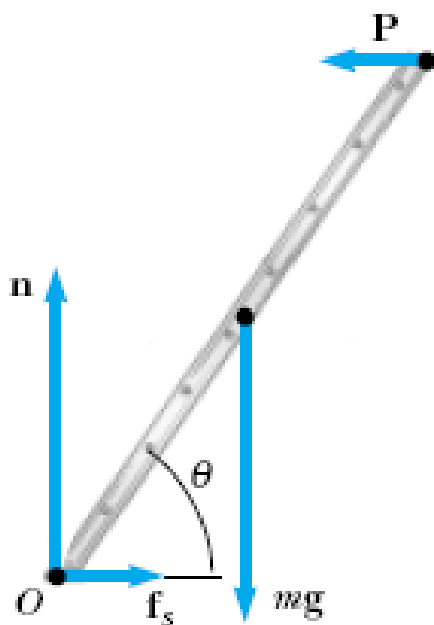
$$(1) \quad \sum F_x = f_s - P = 0 \quad \sum F_y = n - mg = 0$$

$$(2) \quad P = f_s = \mu_s mg$$

$$(3) \quad \sum \tau_O = P\ell \sin \theta - mg \frac{\ell}{2} \cos \theta = 0$$

$$\tan \theta_{\min} = \frac{mg}{2P} = \frac{mg}{2\mu_s mg} = \frac{1}{2\mu_s} = 1.25$$

$$\theta_{\min} = 51^\circ$$



$$(4) \quad \sum F_x = f_s - P = 0$$

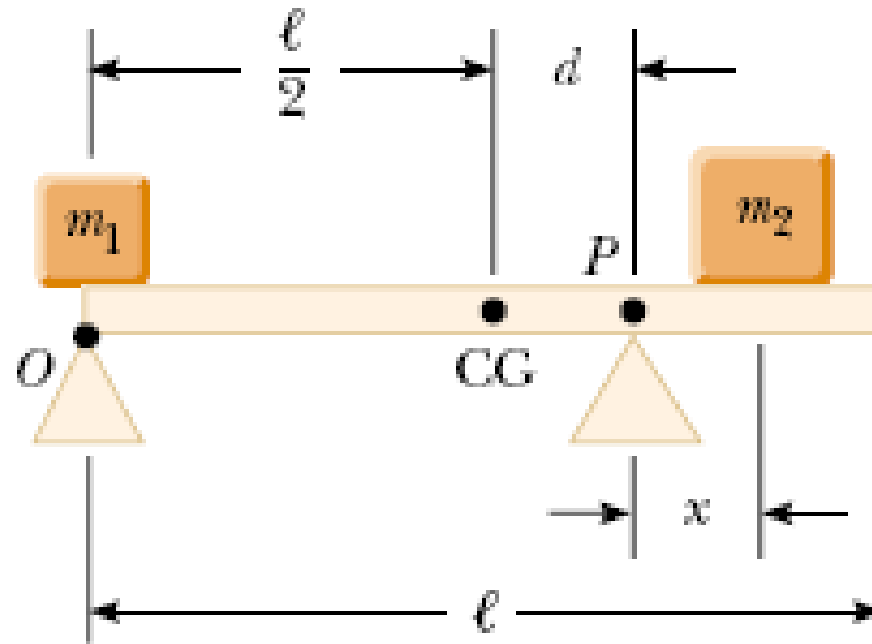
$$(5) \quad \sum F_y = n - (m + M)g = 0$$

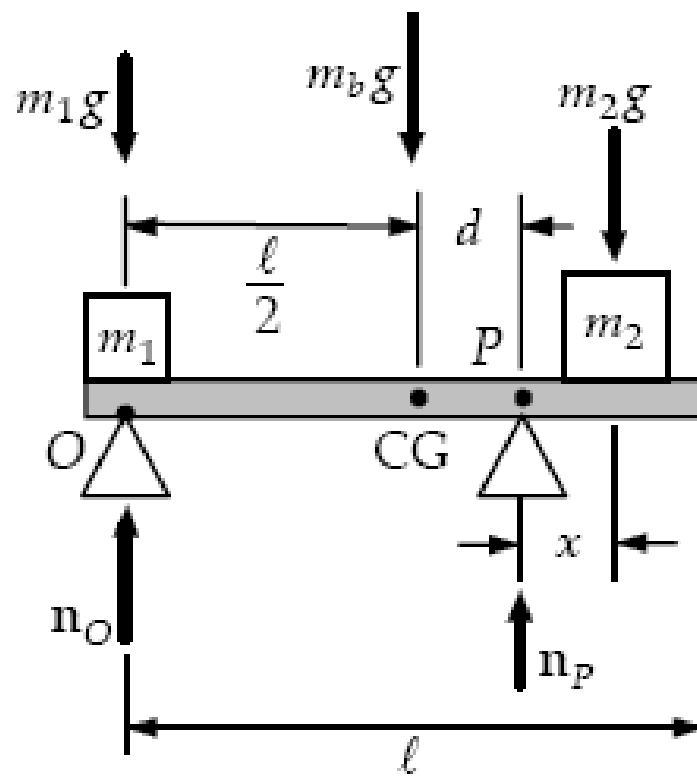
$$\sum \tau_O = P\ell \sin \theta - mg \frac{\ell}{2} \cos \theta - Mg\ell \cos \theta = 0$$

$$\tan \theta = \frac{mg(\ell/2) + Mg\ell}{P\ell}$$

$$(6) \quad \tan \theta_{\min} = \frac{m(\ell/2) + Md}{\mu_s \ell (m + M)}$$

Soru : Dengede olan şekildeki sistem için x mesafesini hesaplayınız.

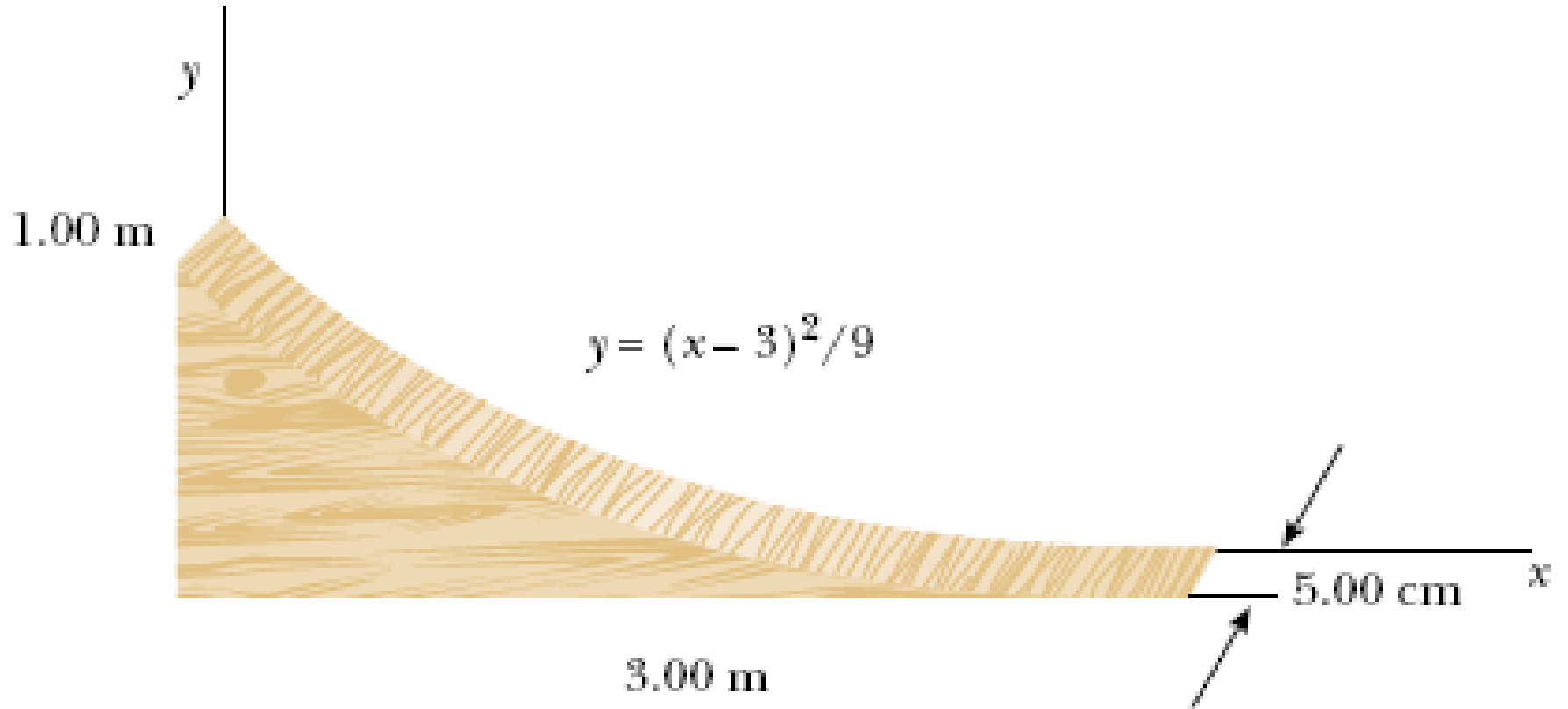




$$\sum \tau_p = -n_0 \left[\frac{\ell}{2} + d \right] + m_1 g \left[\frac{\ell}{2} + d \right] + m_b g d - m_2 g x = 0$$

$$x = \frac{(m_1 g + m_b g) d + m_1 g \frac{\ell}{2}}{m_2 g} = \frac{(m_1 + m_b) d + m_1 \frac{\ell}{2}}{m_2}$$

Örnek : Şekildeki cismin kütle merkezini bulunuz.

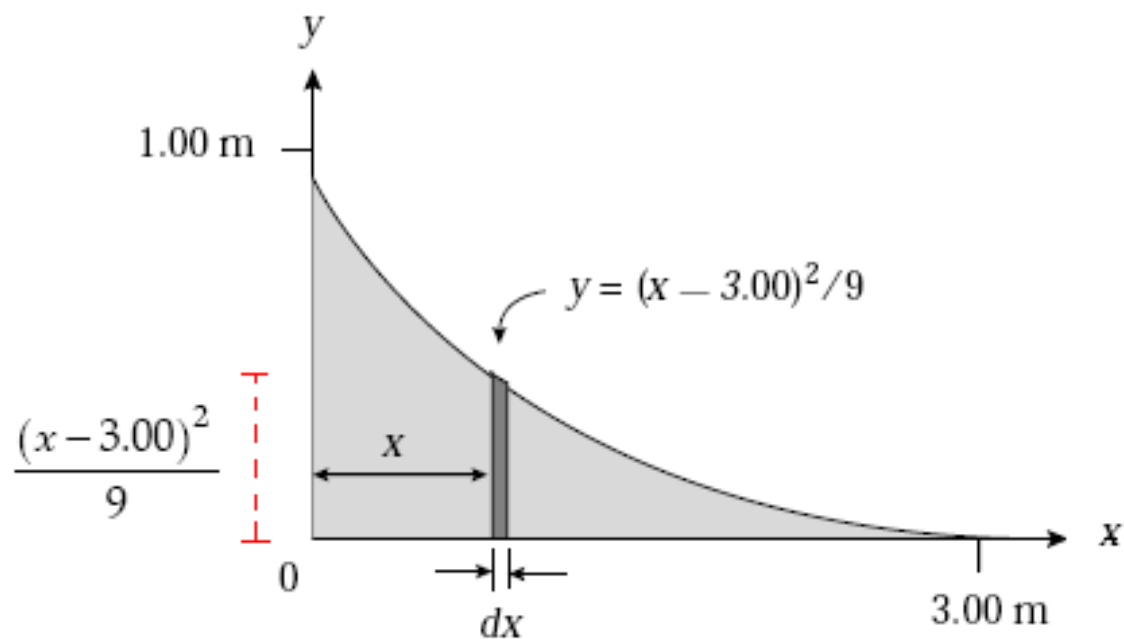


σ kütle yoğunluğu olsun

$$dm = \frac{\sigma(x-3.00)^2}{9} dx$$

$$M = \int dm = \int_{x=0}^{3.00} \frac{\sigma(x-3)^2}{9} dx = \sigma$$

$$x_{KM} = \frac{\int x dm}{M} = \frac{1}{9\sigma} \int_0^{3.00} \sigma x (x-3)^2 dx$$
$$= 0.750 \text{ m}$$



Örnek : Dengede olan şekildeki sistem için m kütlesi kaçtır?

$$\sum \tau = 0 = mg(3r) - Tr$$

$$2T - Mg \sin 45.0^\circ = 0$$

$$T = \frac{Mg \sin 45.0^\circ}{2} = \frac{1500 \text{ kg}(g) \sin 45.0^\circ}{2}$$

$$= (530)(9.80) \text{ N}$$

$$m = \frac{T}{3g} = \frac{530g}{3g} = \boxed{177 \text{ kg}}$$

