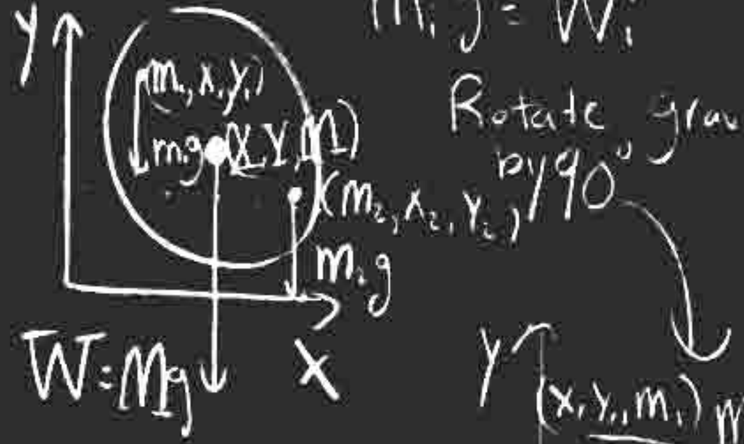
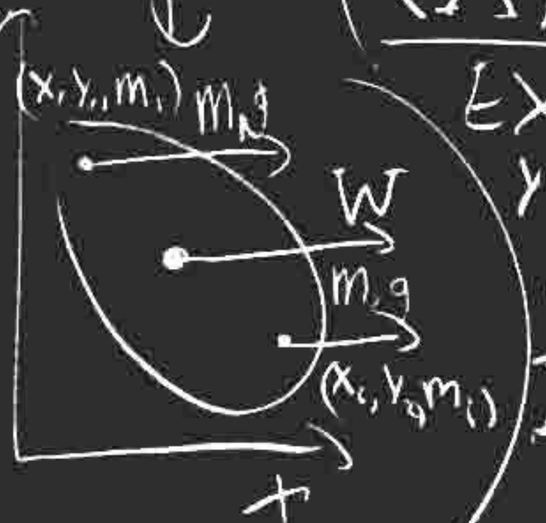
Center of Gravity

$m_i g = W_i$



Rotate gravity by 90°



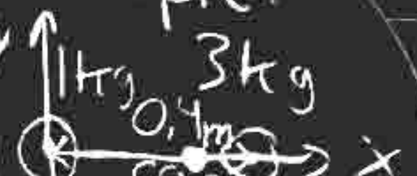
$$X = \frac{\sum W_i x_i}{\sum W_i}$$

$$W = \sum W_i$$

$$Y = \frac{\sum W_i y_i}{\sum W_i}$$

Center of Gravity = (X, Y)

Example



$$X = \frac{\sum W_i x_i}{\sum W_i}$$

$$X = \frac{(3kg)(9.8m/s^2)(0.4m) + 0}{(3kg)(9.8m/s^2) + (1kg)(9.8m/s^2)}$$

$$= \frac{1.2\,kg\,m}{4\,kg} = 0.3m$$

c.o.g = 0.3m away from the 1kg ball and 0.1m away from 3kg ball

Force not through C.O.G. Changes Rotation and translational Motion

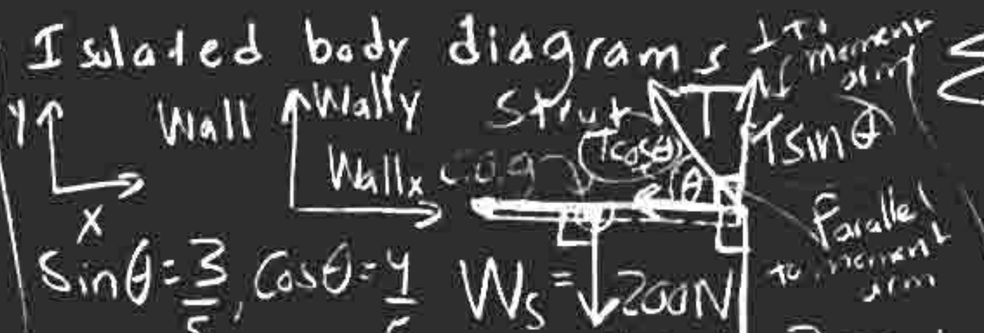
IF a force or its line of action does through C.O.G. ⇒ only affects translational Motion

Total momentum of a body = Velocity of its C.o.g. times its total mass

Example

Find Tension in Cable, Force on wall

Isolated body diagrams



$\sin\theta = \frac{3}{5}$, $\cos\theta = \frac{4}{5}$

$\Sigma F_x = 0 = Wall_x - T\cos\theta$

$\Rightarrow Wall_x = \frac{4}{5}T \leftarrow$

$\Sigma F_y = 0 = Wall_y + T\sin\theta - W_S - W_m$

$Wall_y + \frac{3}{5}T - 200N - 300N = 0$

$Wall_y = 500N - \frac{3}{5}T \leftarrow$

$\Sigma\tau = 0$. Let axis be wall at point of strut (hinge) (no contribution to total τ from $Wall_x$, $Wall_y$, since applied at axis)

C.wise = +, C.wise = − (applied at axis)

$\Sigma\tau = 0 = (T\sin\theta)4m - W_S 2m - W_m 4m$

$0 = T\cdot\frac{3}{5}4m - 200N\cdot 2m - 300N\cdot 4m$

$T\left(\frac{3}{5}4m\right) = 1600N\cdot m$

$\Rightarrow T = \frac{1600Nm}{4m\cdot 3/5} = 667N$

$Wall_x = \frac{4}{5}T = \frac{4}{5}667N = 534N$

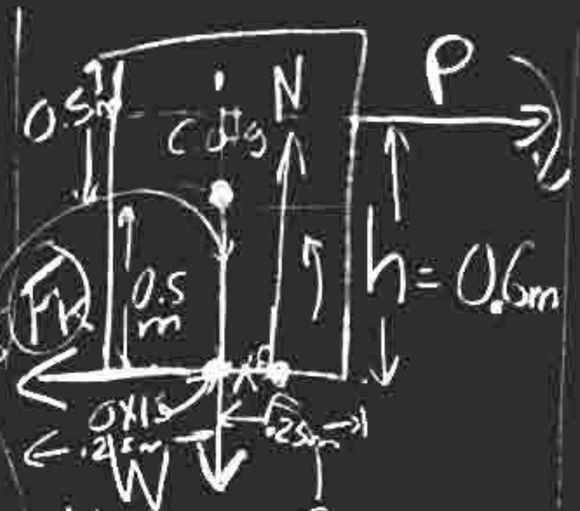
$Wall_y = 500N - \frac{3}{5}T = 500N - \frac{3}{5}667N$

$= 500N - 400N = 100N$

Drag block along level surface at constant speed, $\mu_k = 0.40$

Block weighs 25 N, with center of gravity at center

.5 m wide by 1.0m high.



Normal force displaced from center when reaches edge → Tips over.

$\Sigma F_x = 0 = P - F_k \Rightarrow P = F_k$

$\Sigma F_y = 0 = N - W \Rightarrow N = W = 25N$

Find Line of action of Normal force (i.e what is X?)

Put axis at center of block at bottom

X = dist. from C.o.g (in X direction) to line of action of N.

$\Sigma \tau = 0 = Nx - Ph \Rightarrow Nx = Ph$

$x = Ph/W$

$P = F_K = \mu_K N =$

$40 \cdot 25N = 10N$

$X = \frac{(10N)(0.6m)}{25N}$

$= 20\,cm$

$\sum F_x = F_s - P = 0$

$\sum F_y = N - mg = 0$

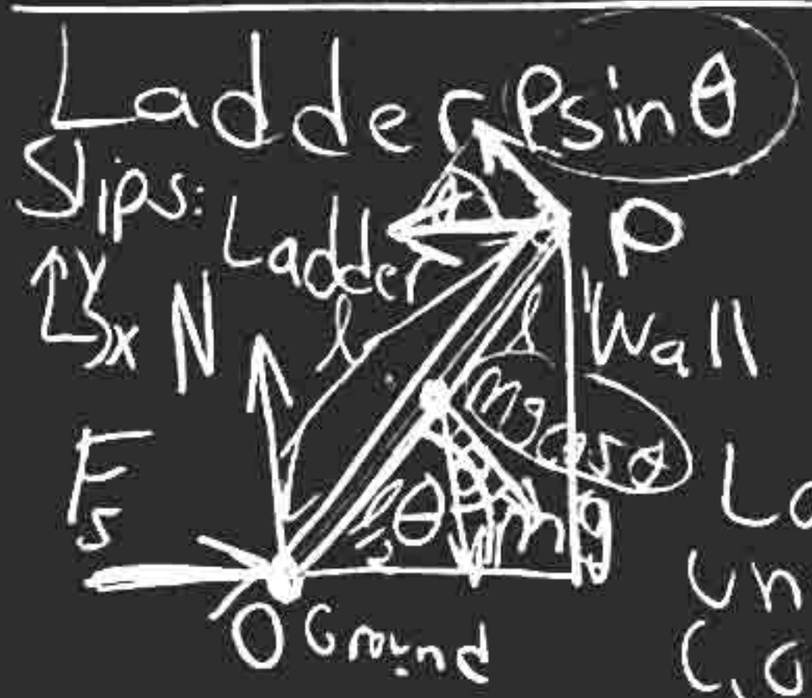
$\sum \tau = Pl\sin\theta - mg\frac{l}{2}\cos\theta = 0$

$Pl\sin\theta = mg\frac{l}{2}\cos\theta$

$\tan\theta = \frac{mg}{2P}$

Ladder

Slips:



Ladder uniform → C.G. at center