Chapter 12 Static Equilibrium and Elasticity

Stationary remains stationary $\Rightarrow$ ~~static~~ equilibrium
static
(not to be confused with stable equilibrium)

Why important? $\Rightarrow$ e.g. building bridges

Conditions?

1. Net force = 0 $\qquad \sum_i \vec{F}_i = 0$

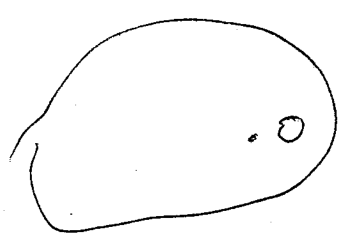
2. Can still rotate

Net torque = 0 about any pt $\qquad \sum_i \vec{\tau}_i = 0$

choose ~~[illegible]~~ pivot point to simplify calculations!

Center of Gravity

Rigid body: composed of many particles

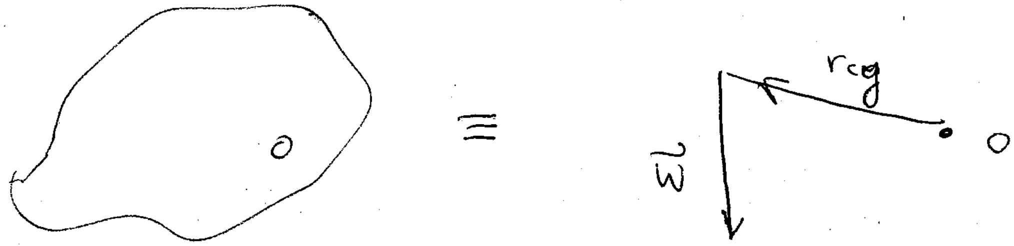


$$\vec{W} = \sum_i \vec{w}_i$$

$$\vec{\tau}_i = \vec{r}_i \times \vec{w}_i \quad \text{torque about } O$$

$$\vec{\tau}_{net} = \sum_i \vec{r}_i \times \vec{w}_i$$

Center of gravity



$$\boxed{\vec{\tau}_{net} = \vec{r}_{cg} \times \vec{W}}$$

$\vec{r}_{cg}$ = position vector of center of gravity relative to o

For uniform gravitational field,

$$\boxed{\vec{r}_{cg} = \vec{r}_{cm}}$$

Proof: $\vec{\tau}_{net} = \sum_i \vec{r}_i \times \vec{W}_i = \sum_i \vec{r}_i \times m_i \vec{g}$

$$= \sum_i m_i \vec{r}_i \times \vec{g}$$

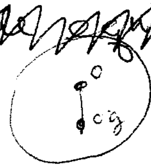
$$= \left(\sum_i m_i \vec{r}_i\right) \times \vec{g}$$

$$= M \vec{r}_{cm} \times \vec{g}$$

$$= \vec{r}_{cm} \times (M\vec{g}) = \vec{r}_{cm} \times \vec{W}$$

$\Rightarrow \vec{r}_{cg} = \vec{r}_{cm}$

~~[illegible]~~ When o is directly above center of gravity



$\vec{\tau}_{net} = \vec{r}_{cg} \times \vec{W} = 0 \Rightarrow$ static equilibrium