Physics 4A
March 3, 2015

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UCSD Physics

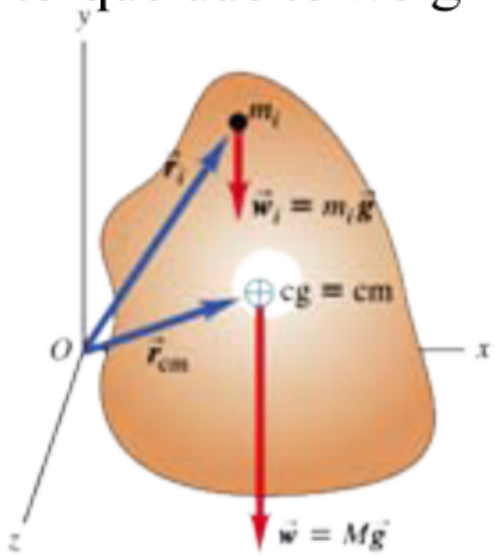
Center Of Gravity

In many situations one of the forces acting on the rigid body is gravity. The weight of the body is distributed over entire body $\Rightarrow$ need to be able to calculate torque due to weight

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

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

$$\Rightarrow \vec{\tau} = \vec{r}_{cm} \times \vec{w}$$

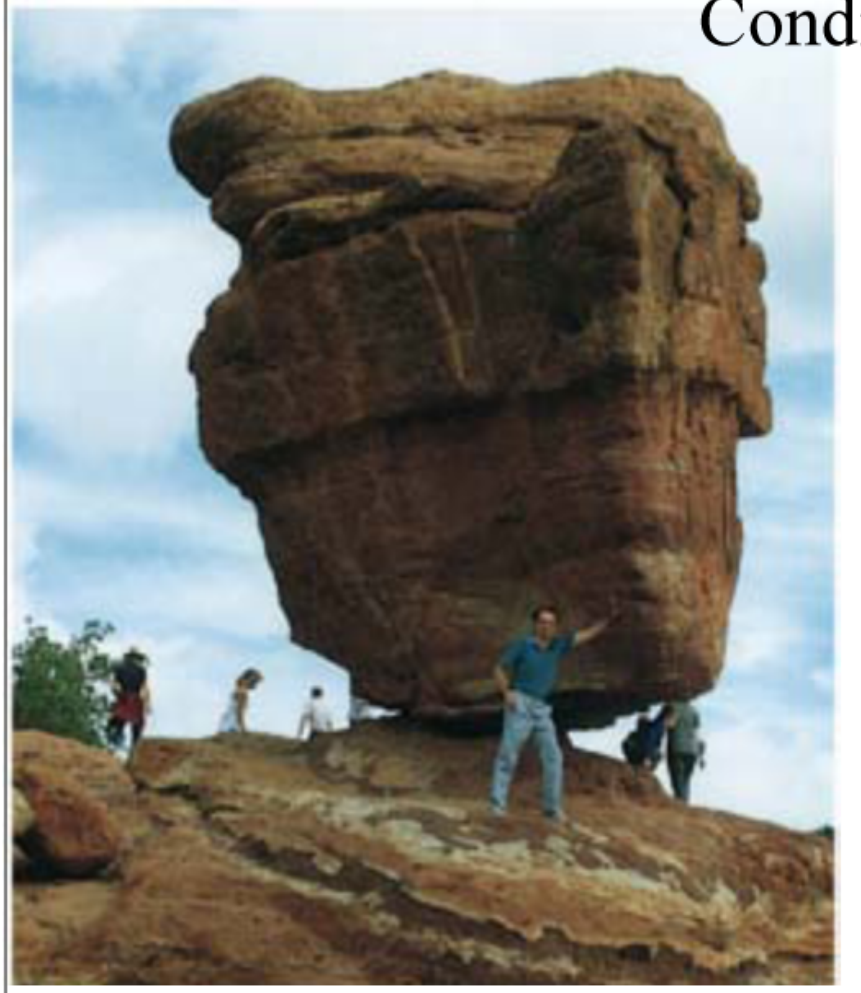


Total τ_{grav} is same as if total weight was acting at $\vec{r}_{cm}$

Define CG as the point at which gravity can be considered to act.

If $\vec{g}$ has same value over entire body then CG=CM

Conditions for Equilibrium:



CM of rigid body has $\vec{a}=0 \Rightarrow \sum \vec{F} = 0$

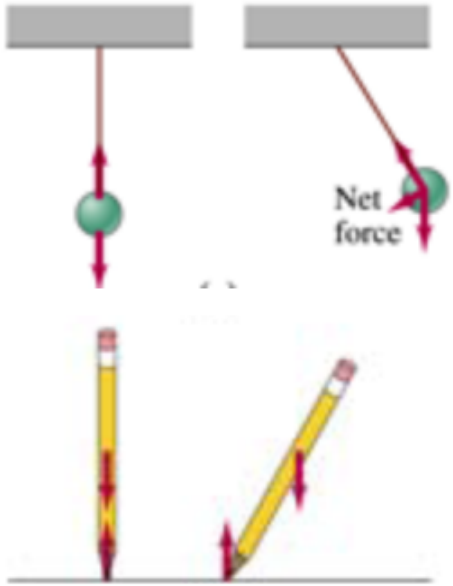
can't have tendency to start rotating about any point $\Rightarrow \sum \vec{\tau} = 0$

Stability & Balance

Body in static equilibrium, if left undisturbed, will undergo no translational or rotational acceleration

If object disturbed, 3 outcomes possible:

1. Stable equilibrium: object returns to its original position



2. Unstable Equilibrium: Object moves even further away from its original position

3.Neutral Equ.: Object stays in new position (like a sphere on a flat table)