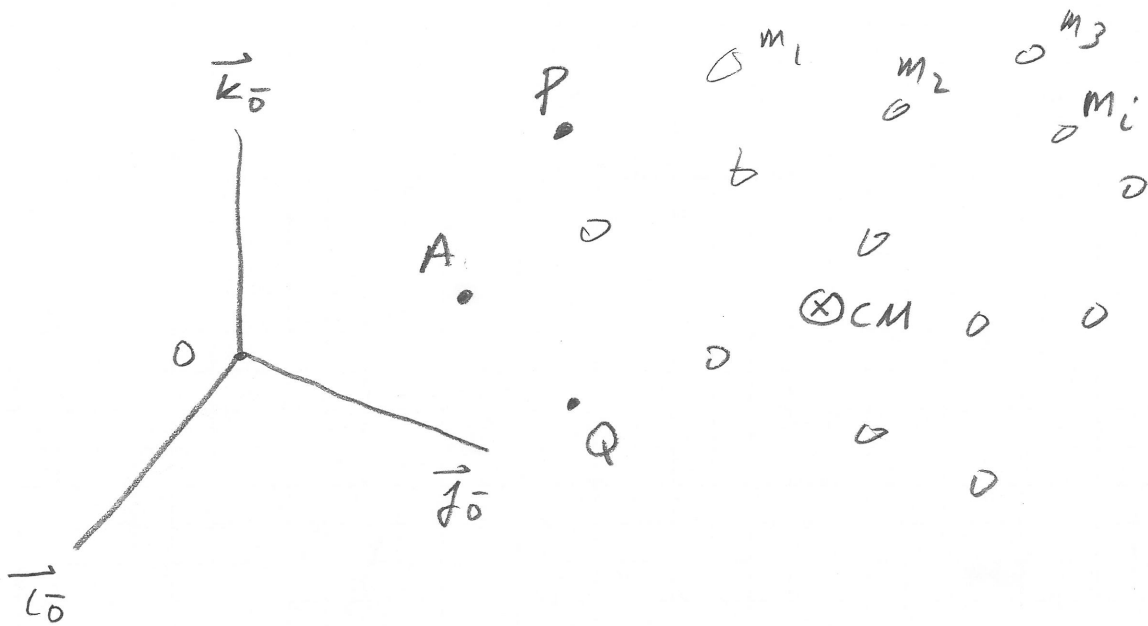


MAE 789 students

We will go over this  
on Monday - Please review  
and let me know if you  
see any potential errors.

Thanks,

-AM



$$\vec{r}_{CM/O} = \frac{\sum m_i \vec{r}_{mi/O}}{m_{TOT}}$$

$$m_{TOT} = \sum m_i$$

$$\vec{r}_{CM/P} = \frac{\sum m_i \vec{r}_{mi/P}}{m_{TOT}}$$

$$\vec{r}_{CM/A} = \frac{\sum m_i \vec{r}_{mi/A}}{m_{TOT}}$$

$$\vec{r}_{CM/Q} = \frac{\sum m_i \vec{r}_{mi/Q}}{m_{TOT}}$$

$$\vec{v}_{CM/O} = \frac{\sum m_i \vec{v}_{mi/O}}{m_{TOT}}$$

$$\vec{v}_{CM/P} = \frac{\sum m_i \vec{v}_{mi/P}}{m_{TOT}}$$

$$\vec{v}_{CM/A} = \frac{\sum m_i \vec{v}_{mi/A}}{m_{TOT}}$$

$$\vec{v}_{CM/Q} = \frac{\sum m_i \vec{v}_{mi/Q}}{m_{TOT}}$$

$$\vec{h}_{mi/A} = \vec{r}_{mi/A} \times m_i \vec{v}_{mi/Q}$$

$$\vec{h}_A = \sum \vec{h}_{mi/A} = \sum \vec{r}_{mi/A} \times m_i \vec{v}_{mi/Q}$$

$$\vec{r}_{m/A} = \vec{r}_{P/A} \times \vec{r}_{m/P} \quad \vec{r}_{m/Q} = \vec{r}_{P/Q} + \vec{r}_{m/P}$$

$$\vec{U}_{m/Q} = \vec{U}_{P/Q} + \vec{U}_{m/P} =$$

$$\vec{U}_{m/P} = \vec{\omega} \times \vec{r}_{m/P}$$

$$\vec{h}_A = \sum \vec{r}_{m/A} \times m_i \vec{U}_{m/Q} =$$

$$= \sum \vec{r}_{m/A} \times m_i \vec{U}_{P/Q} + \sum \vec{r}_{m/A} \times m_i \vec{U}_{m/P}$$

$$= \sum m_i \vec{r}_{m/A} \times \vec{U}_{P/Q} + \sum \vec{r}_{P/A} \times m_i \vec{U}_{m/P} + \sum \vec{r}_{m/P} \times m_i \vec{U}_{m/P}$$

$$= m \vec{r}_{cm/A} \times \vec{U}_{P/Q} + \vec{r}_{P/A} \times m \vec{U}_{cm/P} + \underbrace{\sum \vec{r}_{m/P} \times m_i \vec{U}_{m/P}}_{\vec{B}_P \vec{h}_P} + \underbrace{\sum \vec{r}_{m/P} \times m_i (\vec{\omega} \times \vec{r}_{m/P})}_{\vec{I}_P \cdot \vec{\omega}}$$

$$\vec{h}_A = \vec{r}_{cm/A} \times m \vec{U}_{P/Q} + \vec{r}_{P/A} \times m \vec{U}_{cm/P} + \vec{B}_P \vec{h}_P =$$

$$= \vec{r}_{cm/A} \times m \vec{U}_{P/Q} + \vec{r}_{P/A} \times m \vec{U}_{cm/P} + \vec{B}_P \vec{h}_P + \vec{I}_P \cdot \vec{\omega}$$

Valid for  
any system  
of particles