Physics 113 - October 26, 2006

- Projects ?
- I'll be asking for Topics/groups soon

Last Time

$$\vec{F} = \frac{d\vec{p}}{dt} = \frac{d(m\vec{v})}{dt}$$

$$\vec{p} \equiv m\vec{v} \equiv \text{Momentum}$$

momentum always conserved
for "isolated" systems

$$\Sigma \vec{P}_i = \Sigma \vec{P}_f \qquad \text{vector eqn}$$

Energy conservation

Always true ... NOT always useful

If KE is conserved → Elastic collision

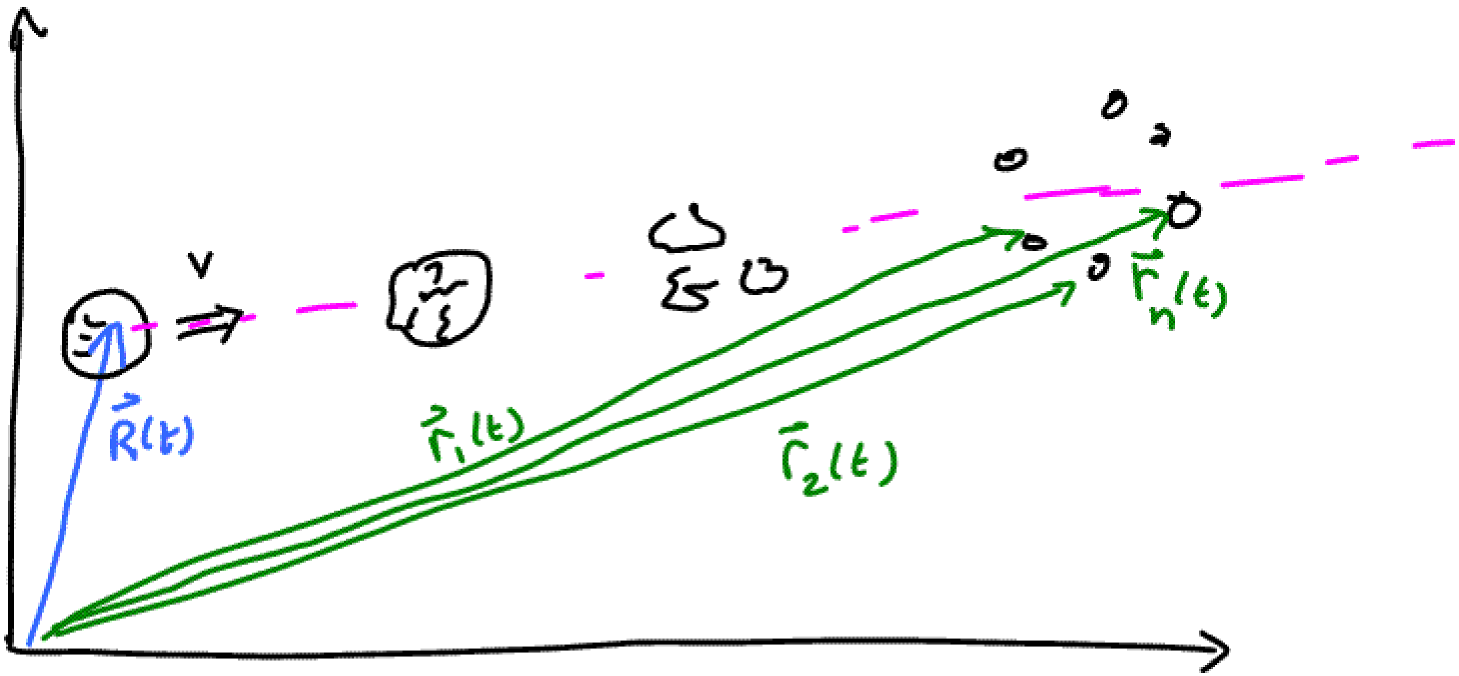
$$\boxed{\Sigma KE_i = \Sigma KE_f}$$

Think billiards

If KE is NOT conserved → inelastic collision

$$\Sigma KE_i \neq \Sigma KE_f$$

Center of Mass, Center of Mass coordinates



Momentum Conservation

$$\sum \vec{P}_i = \sum \vec{P}_f$$

$$M\vec{V} = m_1\vec{V}_1 + m_2\vec{V}_2 + \cdots + m_n\vec{V}_n$$

$$M\frac{d\vec{R}}{dt} = m_1\frac{d\vec{r}_1}{dt} + m_2\frac{d\vec{r}_2}{dt} + \cdots + m_n\frac{d\vec{r}_n}{dt}$$

$$M\vec{R} = m_1\vec{r}_1 + m_2\vec{r}_2 + \cdots + m_n\vec{r}_n$$

$\vec{R} = (X, Y, Z)$

$\vec{r}_1 = (x_1, y_1, z_1)$

$\vdots$

$$MX = m_1x_1 + m_2x_2 + \cdots + m_nx_n$$

$$MY = m_1y_1 + m_2y_2 + \cdots + m_ny_n$$

$$MZ = m_1z_1 + \cdots + m_nz_n$$

$\vec{R}$ or X, Y, Z center-of-mass coordinates

$$X = \frac{m_1 x_1 + m_2 x_2 + \cdots + m_n x_n}{M}$$

$M = m_1 + m_2 + \cdots + m_n$

discrete masses

Center of Mass Coordinates

$$X_{cm} = \frac{\sum_i m_i x_i}{\sum_i m_i}$$

mass weighted x position of system

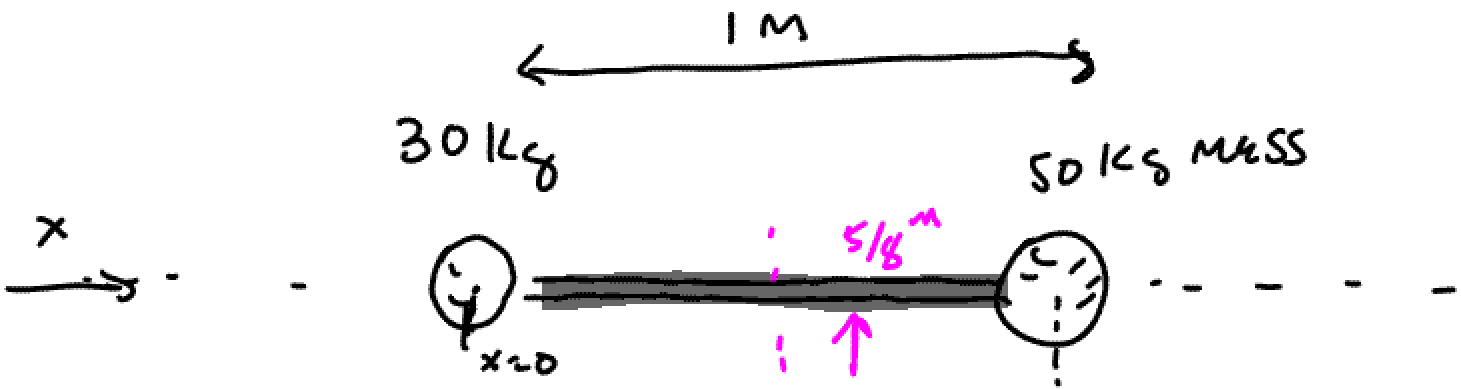
$$Y_{cm} = \frac{\sum_i m_i y_i}{\sum_i m_i}$$

$$\vec{R} = \frac{\sum m_i \vec{r}_i}{\sum m_i}$$

$$Z_{cm} = \frac{\sum_i m_i z_i}{\sum_i m_i}$$

Important

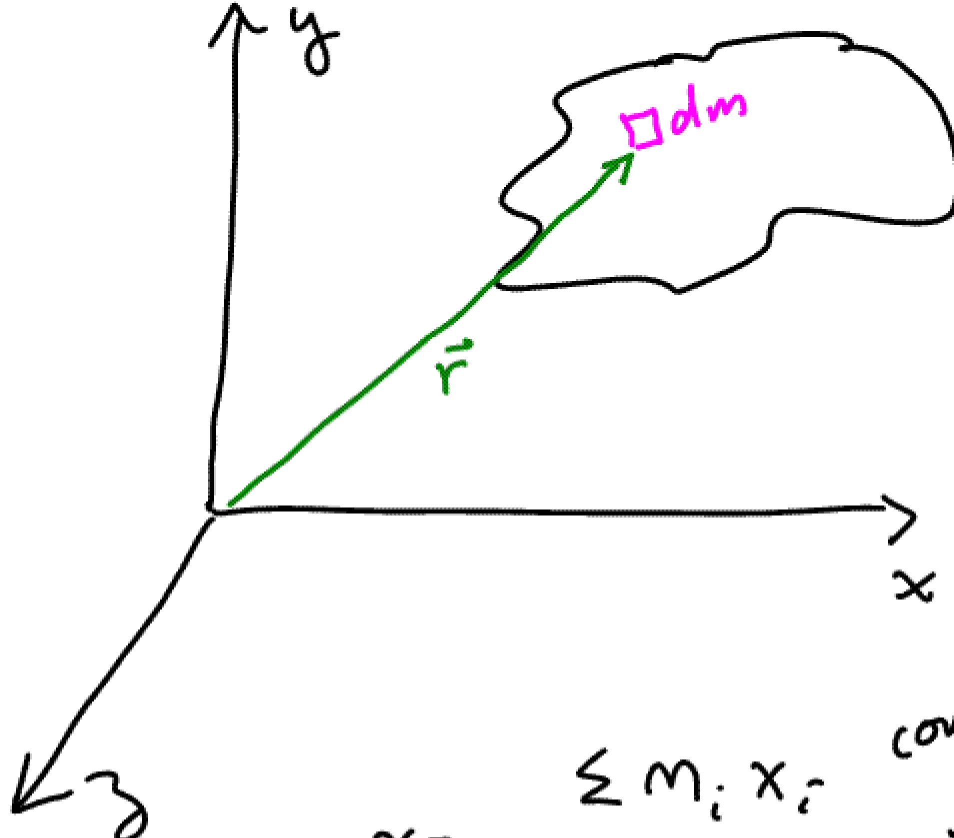
Can consider a system of bodies to be equivalent to one body w/ same (total) mass located at the center-of-mass



where is CM of system

$$X_{CM} = \frac{\sum x_i m_i}{\sum m_i} = \frac{\overset{0}{x_1} 30 + (1\,m)(50)}{30 + 50}$$

$$= \frac{5}{8}\,m$$



$$\int_v \equiv \int_{vol}$$

≡ integration over TOTAL volume

$$x = \frac{\sum m_i x_i}{\sum m_i} \xrightarrow{\text{continuous limit}} \frac{\int_{vol} x \, dm}{\int_{vol} dm}$$

TOTAL Mass

C.M. coords for continuous body

$$Y = \frac{\int_v y \, dm}{\int dm} \qquad Z = \frac{\int_v z \, dm}{\int dm}$$

Important

$$\vec{R} = \frac{\int_V \vec{r}\, dm}{\int_V dm}$$

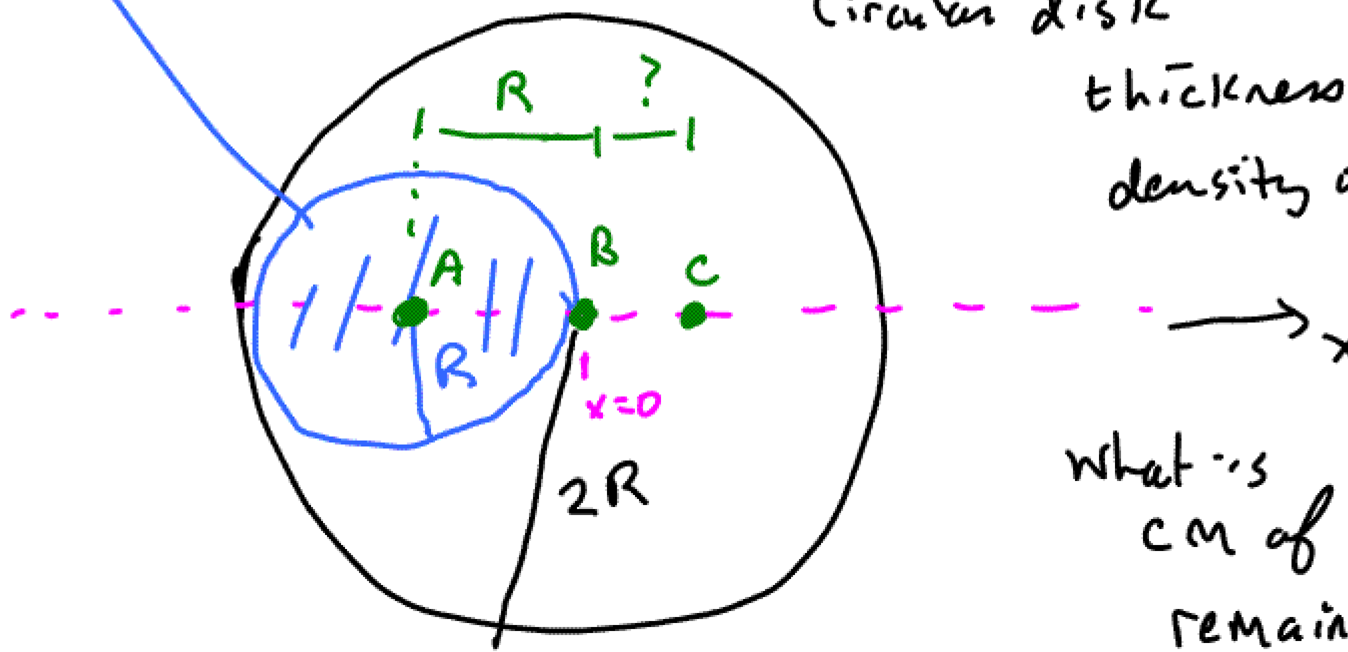
Example

Remove circular plug

Circular disk

thickness of t

density of ρ



what is cm of remaining Piece along x

$$0 \equiv X_B = \frac{M_{plug} X_A + M_{Disk-plug} X_c}{M_{plug} + M_{disk-plug}}$$

$$M_p X_A + M_{D-p} X_c = 0$$

$$X_c = \frac{-M_p X_A}{M_{D-p}}$$

$$X_c = -\frac{\rho \pi R^2 t \overset{-R}{X_A}}{\rho \pi (2R)^2 t - \rho \pi R^2 t}$$

$$X_c = \frac{1}{3} R$$