$$\left|\frac{\partial(x,y,z)}{\partial(r,\theta,\phi)}\right| = r^2 \sin\theta$$

$$\left|\frac{\partial(x,y)}{\partial(r,\theta)}\right| = r$$

Conservation of Momentum

$$\vec{p} = m\vec{v} \qquad \text{(momentum)}$$

$$\dot{\vec{P}} = \vec{F}_{\text{ext}} \qquad \text{(3rd law)}$$

Collisions

An *elastic* collision conserves kinetic energy.

$$m_1\vec{v}_1 + m_2\vec{v}_2 = m_1\vec{v}_1{}' + m_2\vec{v}_2{}'$$

An *inelastic* collision does not.

$$m_1\vec{v}_1 + m_2\vec{v}_2 = m\vec{v}\,'$$

Changing Mass idk

Center of Mass

$$M = \int \rho \mathrm{d}V \qquad \text{(total mass)}$$

$$\vec{R} = \frac{1}{M_{\text{tot}}} \int \vec{r} \mathrm{d}m \qquad \text{(location of CoM)}$$

$\mathrm{d}m$ can usually be rewritten in terms of $\mathrm{d}V$

$$\vec{R} = \frac{1}{M_{\text{tot}}} \int \vec{r}\rho(\vec{r})\mathrm{d}V$$

Look for symmetries by which you can substitute $\vec{R}$ and $\vec{r}$ for scalars.