$Notes$

$Basic\ terms\ in\ collision$:

$Suppose\ 2\ bodies\ of\ mass\ m_1\ and\ m_2\ moving\ with\ velocities\ \vec{v}_1\ and\ \vec{v}_2\ collide\ and\ \hat{n}\ denotes\ the\ normal\ to\ the\ common\ surface\ of\ collision$

$We\ can\ define\ the\ velocities\ of\ both\ bodies\ in\ terms\ of\ the\ \hat{n}\ as$

$\vec{v}_{1,\perp}\ \&\ \vec{v}_{2,\perp}\ denote\ the\ component\ of\ velocity\ perpendicular\ to\ \hat{n}\ and\ parallel\ to\ common\ surface$

$\vec{v}_{1,\parallel}\ \&\ \vec{v}_{2,\parallel}\ denote\ the\ component\ of\ velocity\ parallel\ to\ \hat{n}\ and\ perpendicular\ to\ common\ surface$

$We\ say\ a\ collision\ is\ direct\ or\ headon\ if\ \vec{v}_{1,\perp}\ \&\ \vec{v}_{2,\perp}\ are\ both\ zero$

$Coefficent\ of\ restitution$:

$It\ is\ defined\ as\ the\ ratio\ of\ relative\ speed\ of\ seperation\ divided\ by\ relative\ speed\ of\ approach\ after\ and\ before\ collision, or\ we\ can\ write\ mathematically\ that$

$\vec{v}_{2,\parallel,f} - \vec{v}_{1,\parallel,f} = e\left(\vec{v}_{1,\parallel,i} - \vec{v}_{2,\parallel,i}\right)$

$Based\ on\ the\ values\ of\ e, we\ define\ types\ of\ collisions\ as$:

$Perfectly\ elastic\ collision: e = 1$

$Perfectly\ inelastic\ collision: e = 0$

$Partially\ elastic\ collision: 0 < e < 1$

$Finding\ Final\ Velocity$:

$Apply\ conservation\ of\ momentum\ of\ system\ and\ the\ condition\ for\ coefficient\ of\ restitution$

$We\ get, \vec{v}_{2,\perp,f} = \vec{v}_{2,\perp,i}\ and\ \vec{v}_{1,\perp,f} = \vec{v}_{1,\perp,i}\ and$:

$$\vec{v}_{2,\parallel,f} = \frac{m_1\vec{v}_{1,\parallel,i} + m_2\vec{v}_{2,\parallel,i} - em_1\left(\vec{v}_{2,\parallel,i} - \vec{v}_{1,\parallel,i}\right)}{m_1 + m_2}$$

$$\vec{v}_{1,\parallel,f} = \frac{m_1\vec{v}_{1,\parallel,i} + m_2\vec{v}_{2,\parallel,i} - em_2\left(\vec{v}_{1,\parallel,i} - \vec{v}_{2,\parallel,i}\right)}{m_1 + m_2}$$

$We\ can\ also\ calculate\ the\ loss\ of\ energy\ in\ collision\ using\ the\ above\ equations\ and\ that\ is$:

$$\Delta E = \frac{1}{2}(1 - e)\frac{m_1 m_2}{m_1 + m_2}\left|\vec{v}_{2,\parallel,i} - \vec{v}_{1,\parallel,i}\right|^2$$