Physics 321

Hour 5
Linear Momentum and Its Conservation

Four kinds of “collisions”
• Elastic: T conserved
• Inelastic: some energy loss
• Totally inelastic: objects stick – maximum energy loss – energy loss is frame independent, so view the collision from the center of mass frame.
• Bomb: Totally inelastic collision time-reversed

Momentum Conservation
In what collisions can you apply momentum conservation?
• Always – unless external forces accelerate masses during the collision process.
• What does that mean and why is it true?

Geometry
• The two velocity vectors of the projectile before and after the collision define a plane – the “scattering plane”
• If the target is initially at rest, it’s motion is also in the scattering plane.

The Typical Problem
• Given: \( m_1, m_2, \vec{p}_1, \vec{p}_2 \), something about energy loss
• Initially: \( \vec{p} = \vec{p}_1 + \vec{p}_2 \) is known
  \( T = T_1 + T_2 \) is known
• Finally: \( \vec{p'}_1 + \vec{p'}_2 = \vec{p} \)
  \( T'_{1} + T'_{2} = T - E_{loss} \)
• We also know
  \( p'^{1}_{x} = \frac{p'^{2}_{1}}{2m_{1}} \)
  \( p'^{2}_{x} = \frac{p'^{2}_{2}}{2m_{2}} \)
  \( p'^{1}_{y} = p'^{1}_{x} + p'^{1}_{y} \)
  \( p'^{2}_{y} = p'^{2}_{x} + p'^{2}_{y} \)
• 8 unknowns with 7 equations

Special Cases
• Elastic: \( E_{loss} = 0 \)
• Totally Inelastic:
  • \( p'^{1}_{x} = p'^{1}_{2} \)
  • \( M = m_1 + m_2 \)
Specify an Angle

• Let the angle between $\vec{p}$ and $\vec{p}'_1$ be $\theta_1$.
• Assume $T_1$ is known and $T_2 = 0$.
• Find the equations you need to solve.

Mathematica

Collision.nb