Friday, September 26, 2014	Physics 210: Unquiz 04

A mass m_1 collides and sticks to a mass m_2. After the collision, the mass combination is seen to move with a speed v.

(a) If mass m_2 was at rest before the collision, how fast was mass m_1 moving before the collision in terms of m_1, m_2 and v?

(b) What fraction of the initial kinetic energy was lost in this collision in terms of m_1, m_2 and v ?

(c) Suppose the mass combination encounters a frictionless inclined plane with a moderate angle of inclination. How far above the base of the plane will the mass combination be at the instant it stops in terms of v and g?

(d) If m_1 acquired its original momentum from the decompression of a spring of spring constant k, how much was the spring compressed in terms of k, m_1, m_2 and v?

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(a) If mass m_2 was at rest before the collision, how fast was mass m_1 moving before the collision in terms of m_1, m_2 and v?

Assuming that the collision is totally inelastic, we have:

$$\Delta\vec{P}=\vec{0}\Rightarrow m_1 v_{1,b}+m_2 v_{2,b}=(m_1+m_2)v_A : v_{2,b}=0\Rightarrow v_{1,b}=\frac{m_1+m_2}{m_1}v$$

(b) What fraction of the initial kinetic energy was lost in this collision in terms of m_1, m_2 and v ?

For a totally inelastic collision,

$$\text{fraction lost}=1-\frac{K_f}{K_i}$$

$$\Rightarrow 1-\frac{\frac{1}{2}(m_1+m_2)v^2}{\frac{1}{2}m_1 v_{1,b}^2}=1-\frac{(m_1+m_2)v^2}{m_1\left(\frac{m_1+m_2}{m_1}\right)^2 v^2}=1-\frac{m_1}{m_1+m_2}=\frac{m_1+m_2}{m_1+m_2}-\frac{m_1}{m_1+m_2}$$

$$\Rightarrow \text{fraction lost}=\frac{m_2}{m_1+m_2} : \ \%\text{ lost}=100\,x\,\frac{m_2}{m_1+m_2}$$

In particular, note that if $m_2=0$ then no kinetic energy is lost.

(c) Suppose the mass combination encounters a frictionless inclined plane with a moderate angle of inclination. How far above the base of the plane will the mass combination be at the instant it stops in terms of v and g?

Apply energy principles here:

$$\Delta K_{NC}=\Delta K_C+\Delta U$$

$$\Delta K_{NC}=0$$

$$\Delta K_C=K_f-K_i=0-\frac{1}{2}(m_1+m_2)v^2=-\frac{1}{2}(m_1+m_2)v^2$$

$$\Delta U=U_f-U_i=(m_1+m_2)gy-0=+(m_1+m_2)gy$$

$$\Rightarrow 0=-\frac{1}{2}(m_1+m_2)v^2+(m_1+m_2)gy\Rightarrow y=\frac{v^2}{2g}$$

(d) If m_1 acquired its original momentum from the decompression of a spring of spring constant k, how much was the spring compressed in terms of k, m_1, m_2 and v?

$$\Delta K_{NC}=\Delta K_C+\Delta U$$

$$\Delta K_{NC}=0:\Delta K_c=\frac{1}{2}m_1 v_{1,b}^2:\Delta U=\Delta U_s=-\frac{1}{2}kx^2\Rightarrow 0=\frac{1}{2}m_1 v_{1,b}^2-\frac{1}{2}kx^2\Rightarrow x=\sqrt{\frac{m_1}{k}}v_{1,b}$$

$$x=\sqrt{\frac{m_1}{k}}\frac{(m_1+m_2)}{m_1}v=\sqrt{\frac{(m_1+m_2)^2}{km_1}}v$$