Flipping Physics Lecture Notes:

Introductory Elastic Collision Problem Demonstration

Example: Cart 1 has a mass of 2m and cart 2 has a mass of m. Cart 2 is initially at rest. Cart 1 is moving at 40.9 cm/s when it collides elastically with cart 2. If the speed of cart 1 after the collision is 13.4 cm/s, what is the speed cart 2 after the collision?

Knowns: $m_1 = 2m;\ m_2 = m;\ \vec{v}_{1i} = 40.9\frac{cm}{s};\ \vec{v}_{1f} = 13.4\frac{cm}{s};\vec{v}_{2i} = 0;\ \vec{v}_{2f} = ?$

Momentum is conserved during all collisions so: $\sum \vec{p}_i = \sum \vec{p}_f \Rightarrow m_1\vec{v}_{1i} + m_2\vec{v}_{2i} = m_1\vec{v}_{1f} + m_2\vec{v}_{2f}$

$$\Rightarrow (2m)(40.9)+(m)(0)=(2m)(13.4)+(m)\vec{v}_{2f} \Rightarrow (2)(40.9)=(2)(13.4)+\vec{v}_{2f}$$

$$\Rightarrow \vec{v}_{2f} = (2)(40.9)-(2)(13.4) = 55\frac{cm}{s} \Rightarrow v_{2f} \approx \boxed{55.0\frac{cm}{s}}$$ (predicted)

Measured is the slope of the line: $\vec{v}_{2f} = 52.8\frac{cm}{s}$ (measured)

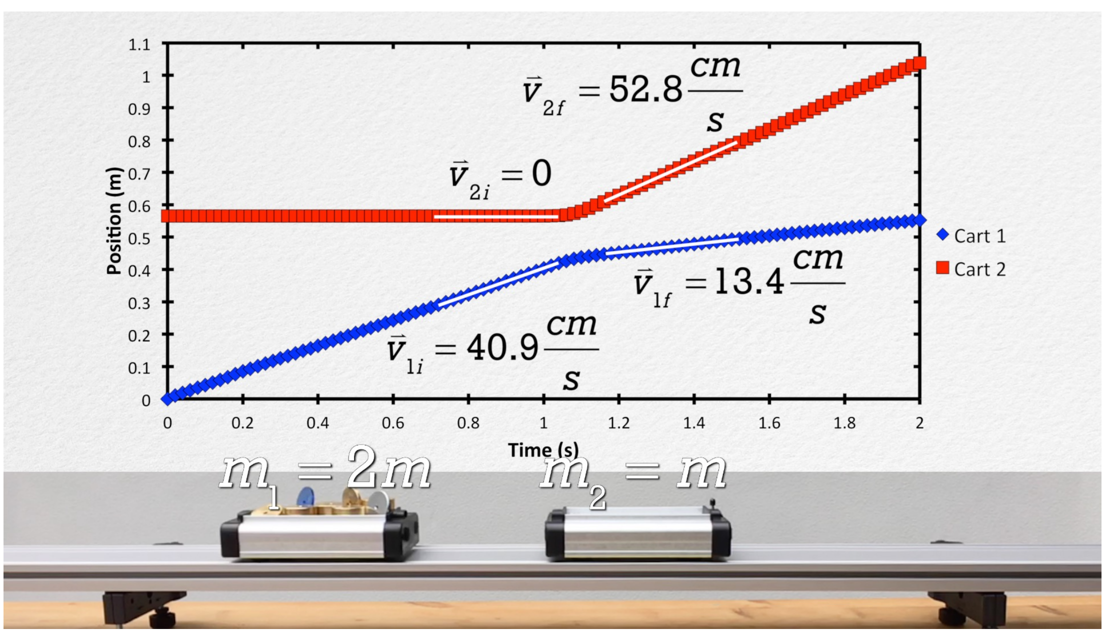
Relative error for our velocity measurement: $E_r = \frac{O-A}{A}\times 100 = \frac{52.8-55}{55}\times 100 = -4 \approx -4.00\%$

Is Kinetic Energy conserved? In other words: $\sum KE_i = \sum KE_f \Rightarrow \frac{\sum KE_f}{\sum KE_i} = 1$

$$\sum KE_i = \frac{1}{2}m_1\left(\vec{v}_{1i}\right)^2 + \frac{1}{2}m_2\left(\vec{v}_{2i}\right)^2 = \frac{1}{2}(2m)(40.9)^2 + \frac{1}{2}(m)(0)^2 = 1672.81m$$

$$\sum KE_f = \frac{1}{2}m_1\left(\vec{v}_{1f}\right)^2 + \frac{1}{2}m_2\left(\vec{v}_{2f}\right)^2 = \frac{1}{2}(2m)(13.4)^2 + \frac{1}{2}(m)(52.8)^2 = 1573.48m$$

$\frac{\sum KE_f}{\sum KE_i} = \frac{1573.48m}{1672.81m} = 0.94062 \Rightarrow 94.1\%$ of the Kinetic Energy remains.



Mr. Becke's Point:

With the mass of the cart in base SI units of kilograms: $m = 517g \times \frac{1kg}{1000kg} = 0.517kg$

When we substitute that into the equation I gave for kinetic energy initial, we get strange units which are not joules:

$$\sum KE_i = 1672.81m = (1672.81)(0.517) = 864.84J \Rightarrow \left(1672.81\frac{cm^2}{s^2}\right)(0.517kg)$$

Remember joules are $J = N \cdot m = \left(\frac{kg \cdot m}{s^2}\right)(m) = \frac{kg \cdot m^2}{s^2}$

Mr.p points out it does not matter in this particular case because the dimensions cancel out:

$$\frac{\sum KE_f}{\sum KE_i} = \frac{1573.48m}{1672.81m} \Rightarrow \frac{kg \cdot cm^2 / s^2}{kg \cdot cm^2 / s^2} \Rightarrow \%$$

However, Mr. Becke is correct that it is better to get in to the habit of converting to base SI units when dealing with energy.