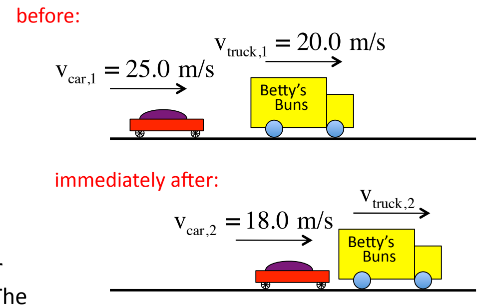
Problem 9.18

A 1,200 kg car runs into the back of a 9000 kg truck, as shown to the right.



a.) What is the truck's velocity immediately after the collision?

This is a class *conservation of momentum* problem. The car applies a force to the truck. The truck applies an equal and opposite (action/reaction) force to the car. All the forces acting in the direction of motion are *internal* to the system, so the momentum of the system will not change through the collision. Sooo:

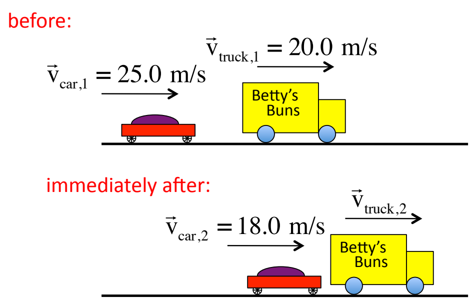
$$\sum p_{1,x} + \sum \cancelto{0}{F_{external,x}} \Delta t_{throughCollision} = \sum p_{2,x}$$

$$\Rightarrow \quad m_c v_{c,1} + m_t v_{t,1} + 0 = m_c v_{c,2} + m_t v_{t,2}$$

$$(1.20\text{x}10^3 \text{ kg})(25.0 \text{ m/s}) + (9.00\text{x}10^3 \text{ kg})(20.0 \text{ m/s})$$
$$= (1.20\text{x}10^3 \text{ kg})(18.0 \text{ m/s}) + (9.00\text{x}10^3 \text{ kg}) v_{t,2}$$

$$\Rightarrow \quad v_{t,2} = 20.9 \text{ m/s}$$

The solution to *Part a* makes sense as the truck *should* experience a push due to the collision, even if it's only a .9 m/s push (there *is* a big mass disparity between the two vehicles!).



b.) What is the change of kinetic energy?

$$KE_1 = \frac{1}{2} m_c (v_{c,1})^2 + \frac{1}{2} m_t (v_{t,1})^2$$
$$= \frac{1}{2}(1.20\text{x}10^3 \text{ kg})(25.0 \text{ m/s})^2 + \frac{1}{2}(9.00\text{x}10^3 \text{ kg})(20.0 \text{ m/s})^2$$
$$= 2.18\text{x}10^6 \text{ J}$$

$$KE_2 = \frac{1}{2} m_c (v_{c,2})^2 + \frac{1}{2} m_t (v_{t,2})^2$$
$$= \frac{1}{2}(1.20\text{x}10^3 \text{ kg})(18.0 \text{ m/s})^2 + \frac{1}{2}(9.00\text{x}10^3 \text{ kg})(20.9 \text{ m/s})^2$$
$$= 2.16\text{x}10^6 \text{ J}$$

The difference between the initial and final mechanical energy in the system is:

$$\Delta KE = KE_2 - KE_1$$
$$= (2.16\text{x}10^6 \text{ J}) - (2.18\text{x}10^6 \text{ J})$$
$$= -2.00\text{x}10^4 \text{ J}$$

NOTE: The text's Solution Manual comes up with a solution that is a little less than half this amount. Although their equation and mine seem comparable, I have no idea how they did that. In any case, I'm feeling OK about what we have done above!

c.) Why the change in the *mechanical energy*?

There is a drop in the mechanical energy of the system. That energy went into deforming the molecular structure of the vehicles (in other words, bending the fenders, etc.), into heating the structures (not a lot, but some) and into the production of sound.