

# Elastic and Inelastic Collisions

## with a Graphing Calculator

**Materials Needed:** a graphing calculator  
paper & pencil

### Background:

Sir Isaac Newton postulated that the *quantity of motion* in the universe is constant. His ‘quantity of motion’ was later termed *momentum*. His hypothesis, along with further study and experimentation, has led to the law of conservation of momentum. The law of Conservation of Momentum states that in any *isolated system* the total momentum is conserved. One can use this fact to model different situations that occur in the real world.

One such example is a *collision*. When two bodies collide they exert forces on each other. According to Newton’s third law, those forces are equal in magnitude and oppositely directed. Those forces applied over a period of time constitute impulses applied to each body by the other. These impulses serve to change the momentum of each body. In *inelastic* collisions the two bodies stick together and move off as one. In *elastic* collisions the two bodies bounce or rebound and go off in various directions. Using the law of conservation of momentum (as well as the law of conservation of energy) one can determine the final speeds of the colliding bodies if the initial conditions are known. Similarly, if the final speeds can be measured, the initial speeds can be determined. This process is used when investigating automobile accidents and other real world phenomena.

### Inelastic collisions in 1-D:

*When bodies collide inelastically, the total momentum of the system is conserved.*

**Ex.** A 2000 kg ice cream truck traveling at 25 mph collides head on with a parked station wagon (1850 kg). If the two cars lock bumpers what will be their final speed?

(Remember, conservation of momentum yields one linear equation and one unknown. Hence, we can solve for the missing variable)

$$P_0 = P_f$$
$$m_1v_{01} + m_2v_{02} = m_1v_1 + m_2v_2$$

## Elastic collisions in 1-D:

*When bodies collide elastically, the total momentum and the **total energy** of the system is conserved.*

**Ex.** A 2200 kg truck traveling at 28.0 mph on an ice covered road plows into a 1400 kg car stopped at a stop light. If the cars are equipped with special bumpers (the latest GM technology?) that make the vehicles bounce instead of stick what will the final speeds of the vehicles be?

(Here, conservation of momentum yields one linear equation and two unknowns so we cannot solve to find an answer. We must obtain a second equation from conservation of energy. The equation from conservation of energy is quadratic but the two equations can be solved simultaneously to find the final speeds. I substituted in y's and x's because I knew that the class would need to do this in order to use the graphing calculators.)

$$P_0 = P_f$$
$$m_1 v_{01} + m_2 v_{02} = m_1 v_1 + m_2 v_2$$

(the 1/2's divide out and you can divide through by 10.)

$$KE_0 = KE_f$$
$$\frac{1}{2} m_1 v_{01}^2 + \frac{1}{2} m_2 v_{02}^2 = \frac{1}{2} m_1 v_1^2 + \frac{1}{2} m_2 v_2^2$$

**Do the following problems to practice:**

\_\_\_\_\_ 1.) p. 208 #26

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\_\_\_\_\_ 2.) Two *identical* pool balls collide as in the picture at right. Find the final velocities of each.

