Head-On Collisions : A Deeper Analysis

- **Head – On Collisions with Mass #2 Initially at Rest**

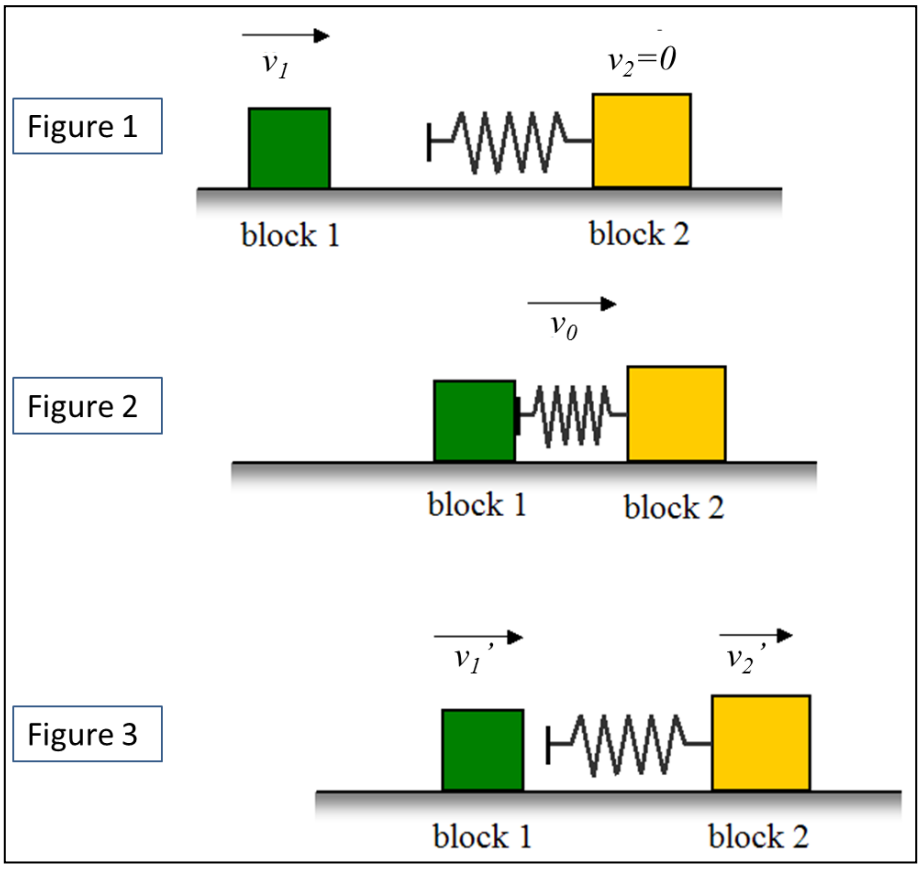
$$V_1' = \left(\frac{m_1 - m_2}{m_1 + m_2}\right)V_1 \qquad V_2' = \left(\frac{2m_1}{m_1 + m_2}\right)V_1$$

The above two equations can be used to calculate the final velocity of the two masses if you know the masses of the two objects and the initial velocity of mass1 (v_1).

- **Transfer of Energy from one object to the other**

In an elastic collision as the objects interact, kinetic energy is transferred from one object to the other. By examining an elastic collision involving a spring we can better understand this transfer of energy. The sequence of images to the right illustrate a collision between a moving block 1 and a stationary block 2.

- Figure 1 – shows block 1 moving at v_1 approaching stationary block 2.
- Figure 2 – shows block 1 and block 2 in contact, with the spring compressed. In this part of the interaction, some of the initial kinetic energy has been transferred into potential energy stored in the spring.
- Figure 3 – shows the two blocks separated from each other with the spring fully extended. The total kinetic energy in Figure 3 should equal the total kinetic energy in Figure 1 (i.e. all of the potential energy stored in the spring has been returned to the blocks).



At minimum separation (as in Figure 2), $v_1=v_2$ (both carts are momentarily moving at the same velocity). We will call this velocity at minimum separation v_0 (it is the velocity during the collision when both objects are moving at the same speed).

Even though kinetic energy is lost to potential (and then returned to kinetic) during this collision, momentum is not lost. Momentum must be conserved (i.e. stay the same) in all parts of this collision.

$$\therefore\ p_{total\_figure1} = p_{total\_figure2} = p_{total\_figure3}$$

Example:
An air track glider of mass 2.0 kg, moving at 20cm/s collides elastically with another glider of mass 0.5 kg, which is initially at rest.

a. What are the velocities of each glider after the collision?
b. What is the velocity of these gliders at the point of minimum separation?
c. What is the total kinetic energy before the collision?
d. What is the total kinetic energy at the point of minimum separation?
e. What maximum potential energy is stored in the bumpers of the gliders during this collision?

- **Velocities after the collision.**

- **Calculating velocity at minimum separation.**

- **Total Kinetic Energy before the collision.**

- **Total Kinetic Energy at point of minimum separation.**

- **Potential Energy Stored in Bumpers (magnetic field) at point of minimum separation.**

Logger Pro Data - 2.0 kg object (Red) Hitting 0.5 kg object (Green)