Física de Colisiones

Colisión Elástica en 1D

In an elastic collision, both momentum and kinetic energy are conserved.[1] Consider particles 1 and 2 with masses m_1, m_2, and velocities u_1, u_2 before collision, v_1, v_2 after collision. The conservation of the total momentum before and after the collision is expressed by:[1]

$$m_1 u_1 + m_2 u_2 \ = \ m_1 v_1 + m_2 v_2 .$$

Likewise, the conservation of the total kinetic energy is expressed by:[1]

$$\tfrac{1}{2} m_1 u_1^2 + \tfrac{1}{2} m_2 u_2^2 \ = \ \tfrac{1}{2} m_1 v_1^2 + \tfrac{1}{2} m_2 v_2^2 .$$

These equations may be solved directly to find v_1, v_2 when u_1, u_2 are known:[2]

$$v_1 \ = \ \frac{m_1 - m_2}{m_1 + m_2} u_1 + \frac{2m_2}{m_1 + m_2} u_2$$

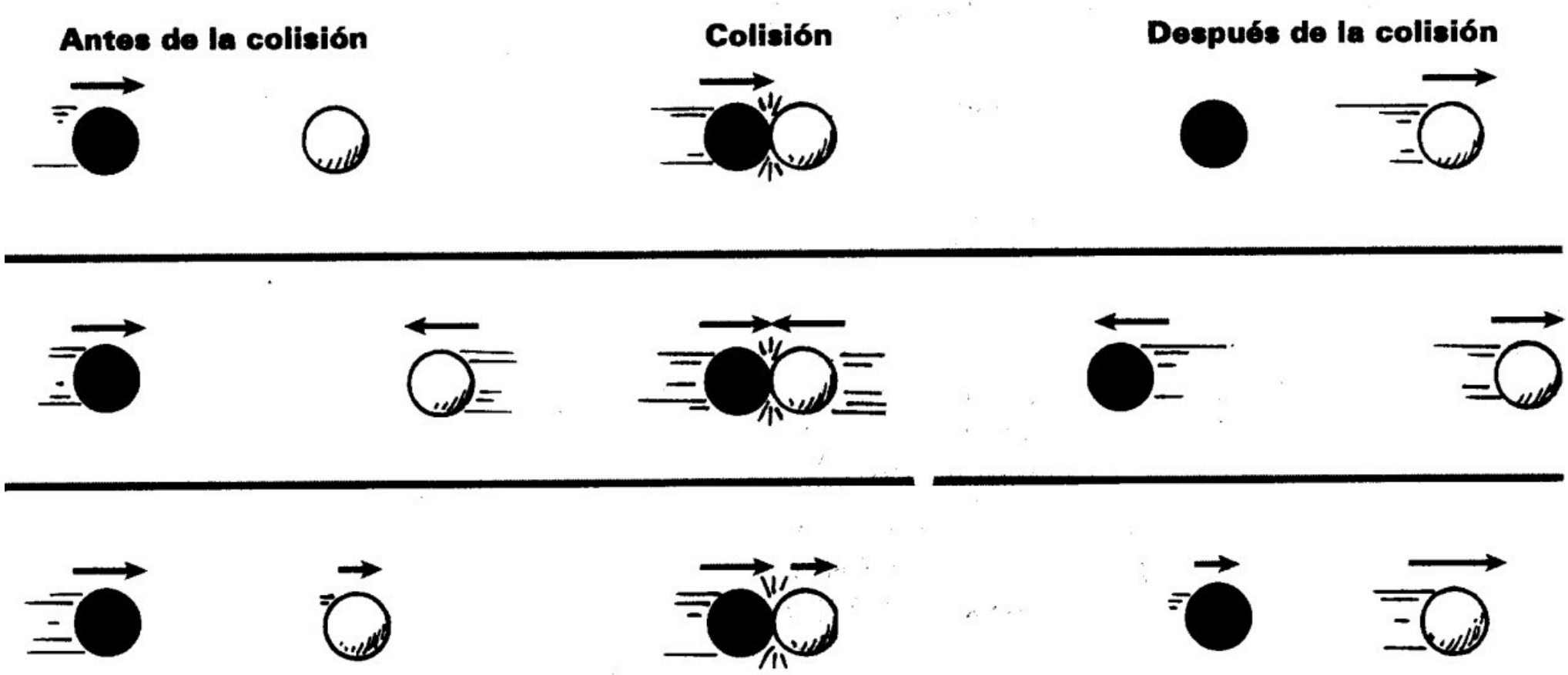
$$v_2 \ = \ \frac{2m_1}{m_1 + m_2} u_1 + \frac{m_2 - m_1}{m_1 + m_2} u_2$$

If both masses are the same, we have a trivial solution:

$$v_1 = u_2$$
$$v_2 = u_1 .$$

This simply corresponds to the bodies exchanging their initial velocities to each other.[2]

https://en.wikipedia.org/wiki/Elastic_collision


Antes de la colisión
Colisión
Después de la colisión

Colisión Elástica en 1D

$$m_1 u_1 + m_2 u_2 = m_1 v_1 + m_2 v_2$$
$$\tfrac{1}{2} m_1 u_1^2 + \tfrac{1}{2} m_2 u_2^2 = \tfrac{1}{2} m_1 v_1^2 + \tfrac{1}{2} m_2 v_2^2$$

Derivation of solution [edit]

To derive the above equations for v_1, v_2, rearrange the kinetic energy and momentum equations:

$$m_1(v_1^2 - u_1^2) = m_2(u_2^2 - v_2^2)$$
$$m_1(v_1 - u_1) = m_2(u_2 - v_2)$$

Dividing each side of the top equation by each side of the bottom equation, and using $\frac{a^2-b^2}{(a-b)} = a + b$, gives:

$$v_1 + u_1 = u_2 + v_2 \quad \Rightarrow \quad v_1 - v_2 = u_2 - u_1 \,.$$

That is, the relative velocity of one particle with respect to the other is reversed by the collision.

Now the above formulas follow from solving a system of linear equations for v_1, v_2, regarding m_1, m_2, u_1, u_2 as constants:

$$\begin{cases} v_1 - v_2 = u_2 - u_1 \\ m_1 v_1 + m_2 v_2 = m_1 u_1 + m_2 u_2 . \end{cases}$$

Once v_1 is determined, v_2 can be found by symmetry.

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Colisión Elástica en 2D

For the case of two colliding bodies in two dimensions, the overall velocity of each body must be split into two perpendicular velocities: one tangent to the common normal surfaces of the colliding bodies at the point of contact, the other along the line of collision. Since the collision only imparts force along the line of collision, the velocities that are tangent to the point of collision do not change. The velocities along the line of collision can then be used in the same equations as a one-dimensional collision. The final velocities can then be calculated from the two new component velocities and will depend on the point of collision

Colisión Elástica en 2D