(M1-4) Conservation of Linear Momentum

Aim of experiment

Apply the law of conservation of linear momentum to determine the velocities of isolated interacting masses

Apparatus

Air Track Rail – Two Gliders of Different Masses – Pressure Pump – 2 Photo Gates Attached to a Speed meter/Timer- Two Fixed Elastic Band

Theory of experiment

Air Track consists of a hollow extruded aluminum beam with small holes drilled into the upper surface. Compressed air is pumped into the beam and released through the holes. This forms a cushion of air supporting a glider on a nearly frictionless surface. The glider can move with almost frictionless horizontal motion

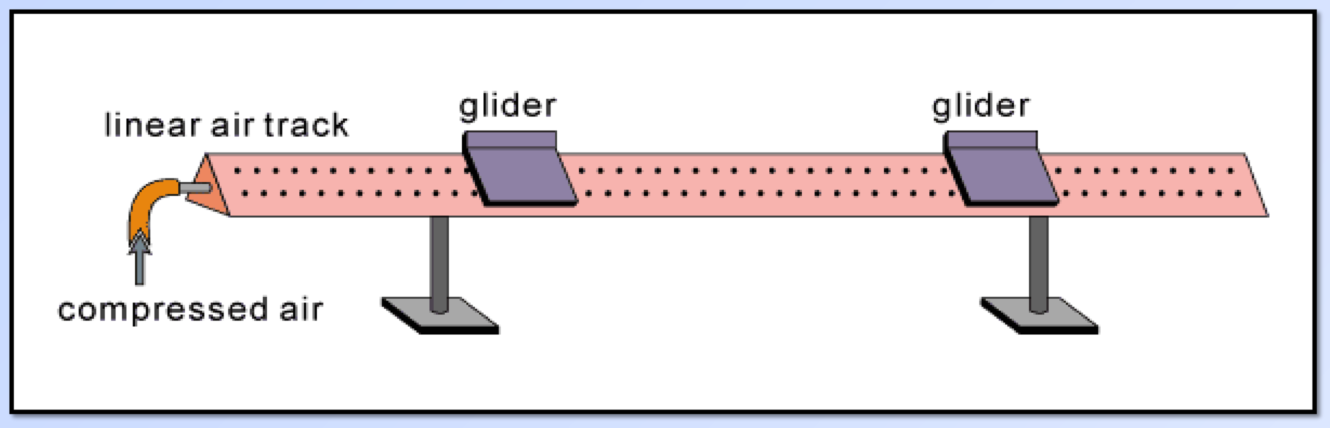

Figure 1. Baic Air Track device

In classical mechanics, linear momentum or translational momentum (SI unit kg m/s, or equivalently, N s) is the product of the mass and velocity of an object.

$$P = m\,v$$

It is a vector quantity

In collisions between two isolated objects *Newton's third law* implies that momentum is always conserved. In collisions, it is assumed that the colliding objects interact for such a short time, that the impulse due to external forces is negligible. Thus the total momentum of the system just before the collision is the same as the total momentum just after the collision. Collisions in which the kinetic energy is also conserved, i.e. in which the kinetic energy just after the collision equals the kinetic energy just before the collision, are called *elastic collision*. In these collisions no ordered energy is converted into thermal energy. Collisions in which the kinetic energy is not conserved, i.e. in which some ordered energy is converted into internal energy, are called inelastic collisions. If the two objects stick together after the collision and move with a common velocity v_f, then the collision is said to be perfectly inelastic**.**

In collisions between two isolated objects, momentum is always conserved. Kinetic energy is only conserved in elastic collisions.

We always have

$$m_1v_{1i} + m_2v_{2i} = m_1v_{1f} + m_2v_{2f}. \qquad (1)$$

Only for elastic collisions we also have

$$\tfrac{1}{2}\, m_1v_{1i}^2 + \tfrac{1}{2}\, m_2v_{2i}^2 = \tfrac{1}{2}\, m_1v_{1f}^2 + \tfrac{1}{2}\, m_2v_{2f}^2. \qquad (2)$$

These two equations can be solved to obtain v_{1f} and v_{2f}

$$v_{1f}\, (m_1 - m_2)/(m_1 + m_2)v_1 + 2m_2/(m_1 + m_2)\, v_2 \qquad (3)$$

and

$$v_{2f} = 2m_1/(m_1 + m_2)\, v_1 + (m_2 - m_1)/(m_1 + m_2)\, v_2 \qquad (4)$$

Where m refers to masses and v refers to speeds before and after collision

So, if initial velocities, v_{1i} and v_{2i} and the masses, m_1 and m_2 are known, then one can determine the final velocities, v_{1f} and v_{2f}, after elastic collision, both theoretically and experimentally, if the system is isolated.

Procedure

1. Turn on the air supply and increase the flow volume until the gliders are floating on a cushion of air. Level the air track by placing a glider in the center of the track and adjusting the leveling screws until the glider will remain at rest.
2. Let both gliders of known masses, moving towards each other, launched from opposite ends of the air track.
3. Record both initial speed, using the photogates and speed meter.
4. After collision, both masses move back away through the photogates and final speeds can be recorded.
5. Repeat steps 2-4.
6. From the initial velocities, calculate the final velocities v_{1cal}', v_{2cal}'.
7. Compare between final calculated and measured speeds.

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Results

v_{1i}	v_{2i}	v_{1f}	v_{2f}	$v_{1cal}{}'$	$v_{1cal}{}'$