Practical work of physics 1

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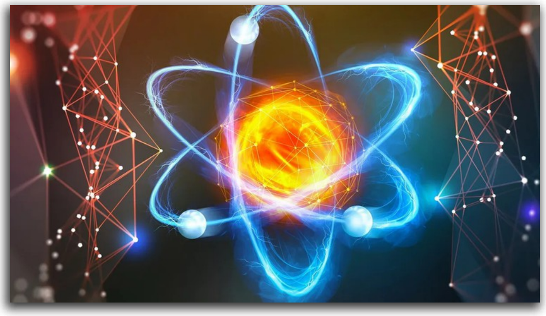

Table of contents

Practical work N°2: Elastic and inelastic collision

1. Objective of practical work N°2

At the end of this practical work, you will be able to **verify** whether the momentum and kinetic energy of the elastic and inelastic collision are conserved by measuring the speeds of the colliding bodies before and after.

2. Introduction

When two moving bodies interact and experience a sudden impact force during their motion, then this event is known as a collision. During the impact, both bodies exert a certain amount of force on each other. This force is known as collision force. Due to the collision, both the bodies change their momentum and energy. In the collision, the determination of velocities can be done with the help of the law of conservation of momentum and the law of conservation of energy.

A collision between two bodies can occur by making actual physical contact and sometimes they don't make any physical contact with each other but a collision occurs. A collision can be perfectly elastic, inelastic, and perfectly inelastic. This video reviews an introduction to the collision.

[cf.Elastic and Inelastic Collisions]

3. Theoretical study

Definition

The momentum of a material point of mass m and speed v is defined by:

$$P = mv$$

The kinetic energy of a material point of mass m and speed v is defined by:

$$E_c = \frac{1}{2}mv^2$$

3.1. Elastic Collision

In an elastic collision, when a collision takes place between two bodies of mass m_1 and mass m_2, then the momentum and the kinetic energy of two bodies will remain the same. A perfectly elastic collision is an ideal case of elastic collision. Figure 2.1 shows an elastic collision.

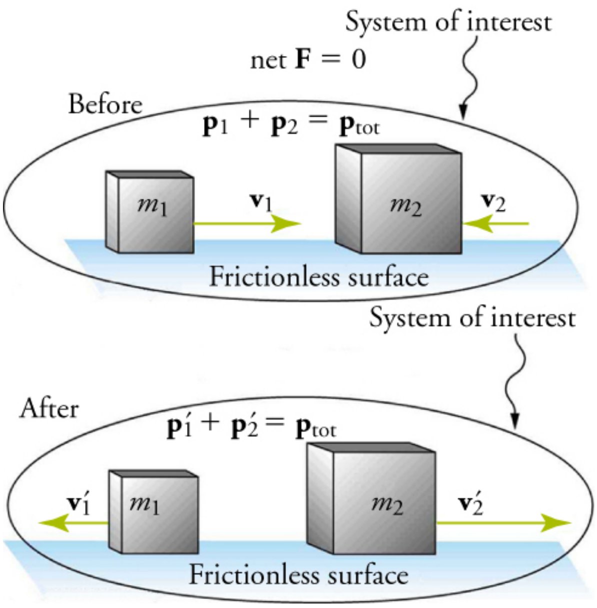

Figure 2.1. Elastic collision

Example

Collisions between atoms and molecules are examples of elastic collision. In the macroscopic world, the collision between billiard balls is a close example of an elastic collision.

We have:

$$P_1 + P_2 = P_1^{'} + P_2^{'}$$

$$E_{c1} + E_{c2} = E_{c1}^{'} + E_{c2}^{'}$$

Where:

$p_1=mv_1$, is the momentum of the body of mass "m_1" before the collision.

$p_2=mv_2$, is the momentum of the body of mass "m_2" before the collision.

$E_{c1}=1/2\ mv_1^2$, is the kinetic energy of the body of mass "m_1" before the collision.

$E_{c2}=1/2\ mv_2^2$, is the kinetic energy of the body of mass "m_2" before the collision.

$p_1'=mv_1'$, is the momentum of the body of mass "m_1" after the collision.

$p_2'=mv_2'$, is the momentum of the body of mass "m_2" after the collision.

$E_{c1}'=1/2\ mv_1'^2$, is the kinetic energy of the body of mass "m_1" after the collision.

$E_{c2}'=1/2\ mv_2'^2$, is the kinetic energy of the body of mass "m_2" after the collision.

Thus, we have:

$$mv_1 + mv_2 = mv_1^{'} + mv_2^{'}$$
$$\frac{1}{2}mv_1^2 + \frac{1}{2}mv_2^2 = \frac{1}{2}mv_1^{'2} + \frac{1}{2}mv_2^{'2}$$

3.2. Inelastic Collision

In an inelastic collision, when two bodies collide with each other, then there will be some loss in the kinetic energy of the body. In this case, the body gets stuck to each other which indicates that one of the bodies has lost its kinetic energy. While momentum of the two bodies is conserved. Figure 2.2 shows an example of an inelastic collision.

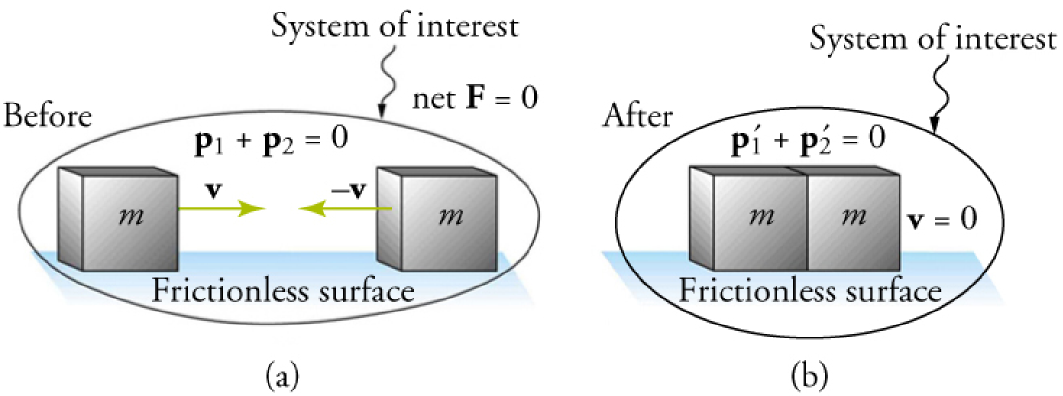

Figure 2.2. Inelastic collision. (a) Two objects of equal mass initially head directly toward each other at the same speed. (b) The objects stick together, creating a perfectly inelastic collision.

Example

Most collisions that occur every day are examples of inelastic collisions such as the collision between two cars or a baseball hitting a bat.

The momentum after the collision is given by:

$$P_1^{'} = \frac{1}{1+\frac{m_2}{m_1}} P_1$$

$$P_2^{'} = \frac{1}{1+\frac{m_1}{m_2}} P_1$$

4. Manipulation

4.1. The equipment

To carry out this experiment we need the following equipment:

- Two carts of masses m_1 and m_2=250+$m_{overload}$,
- Chronometer,
- Two optical barriers.

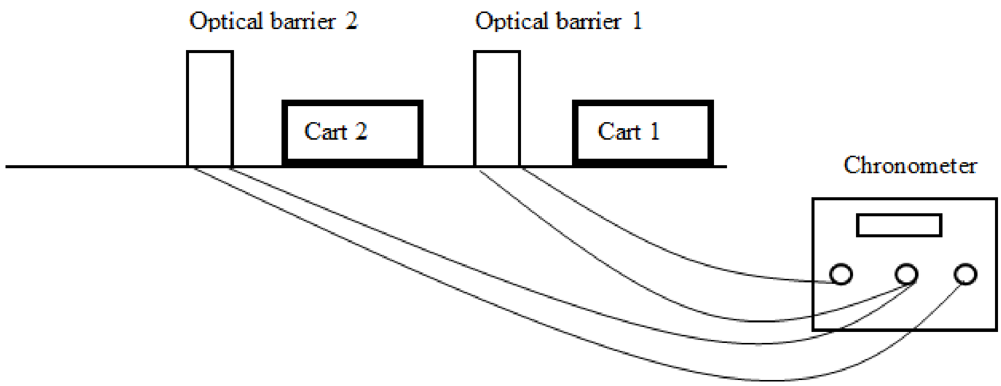

Figure 2.3. The assembly

4.2. Elastic collision

Carry out the assembly as shown in figure 2.3.

Before the collision of the first cart, its mass is fixed m_1=265 gr and is in motion. While the second cart is in a rest state with a variable mass m_2=265+$m_{overload}$ gr.

During the passage of the first cart over the first optical barrier, the chronometer records the corresponding time Δt_1.

After the collision, the two carts move in opposite directions, and each passes through an optical barrier, the chronometer records time twice Δt_1' and Δt_2'.

Repeat the previous steps varying the mass m_2 and complete the following table:

m_2	265	515	765	1015	1265
v_1(m/s)					
v_1'(m/s)					
v_2'(m/s)					
p_{total}(before the collision) (Kg.m/s)					
p_{total}(after the collision) (Kg.m/s)					
E_{total}(before the collision) (J)					
E_{total}(after the collision) (J)					

Note

The time it takes for the tab to pass through the optical barrier is x=5mm.

Based on the table results, is there a conservation of momentum and kinetic energy?

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4.3. Inelastic collision

Carry out the same assembly illustrated in the previous figure.

Before the collision of the first cart, its mass is fixed m_1=265 gr and is in motion. While the second cart is in a rest state with a variable mass m_2=265+$m_{overload}$ gr.

During the passage of the first cart over the first optical barrier, the chronometer records the corresponding time Δt_1.

After the collision, the two carts stick together, move in the same direction with the same speed, and pass through an optical barrier, the chronometer records the corresponding time Δt_2'.

Repeat the previous steps varying the mass m_2 and complete the following table:

m_2	265	515	765	1015	1265
v_1(m/s)					
$v_1'=v_2'$(m/s)					
p_{total}(before the collision) (Kg.m/s)					
p_{total}(after the collision) (Kg.m/s)					
E_{total}(before the collision) (J)					
E_{total}(after the collision) (J)					

Based on the table results, is there a conservation of momentum and kinetic energy?

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5. Conclusion

What did you conclude from the experience?

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