Purpose

The objective of this practical work is to verify the conservation of momentum and kinetic energy by measuring the velocities of the object before and after the collision.

1. Theoretical part

1.2. Elastic collision

Figure 1; representation for an elastic collision between two objects involved in the collision, of mass m_1, m_2 . Impulse and kinetic energy are defined as follows:

a-Before the collision

$\bar{p}_1 = m_1\bar{v}_1$ The impulse of the object with mass m_1

$E_{c1} = \frac{1}{2}m_1\bar{\boldsymbol{v}}_1^2$ The kinetic energy of the object mass m_1

$\bar{p}_2 = m_2\bar{v}_2$ The impulse of the object with mass m_2

$E_{c2} = \frac{1}{2}m_2\bar{\boldsymbol{v}}_2^2$ The kinetic energy of the object mass m_2

b-After the collision

$\bar{p}_1{}' = m_1\bar{v}_1{}'$ The impulse of the object with mass m_1

$E'_{c1} = \frac{1}{2}m_1\bar{\boldsymbol{v}}_1'^{2\,'}$ The kinetic energy of the object mass m_1

$\bar{p}_2{}' = m_2\bar{v}_2{}'$ The impulse of the object with mass m_2

$E'_{c2} = \frac{1}{2}m_2\bar{\boldsymbol{v}}_2'^{2}$ The kinetic energy of the object mass m_2

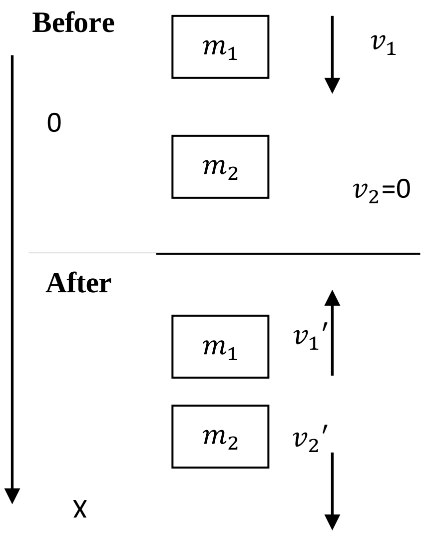

Figure 1

According to the conservation of momentum and ,kinetic energy for the elastic collision. If the collision occurs in one direction then (ox):

$\bar{p} = \bar{p}_1 + \bar{p}_1 = \bar{p}_1' + \bar{p}_2'$ $\quad m_1\bar{v}_1 + m_2\bar{v}_2 = m_1\bar{v}_1{}' + m_2\bar{v}_2{}'$

$E_c = E_{c1} + E_{c2} = E'_{c1} + E'_{c2}$ $\quad \frac{1}{2}m_1\bar{\boldsymbol{v}}_1^2 + \frac{1}{2}m_2\bar{\boldsymbol{v}}_2^2 = \frac{1}{2}m_1\bar{\boldsymbol{v}}_1'^{2\,'} + \frac{1}{2}m_2\bar{\boldsymbol{v}}_2'^{2\,'}$

1- as the momentum in one direction Show that: $v_1 + v_1' = v_2 + v_2'$

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2- To demonstrate that the velocities after the collision are written as follows:

$$v_1' = \left(\frac{m_1 - m_2}{m_1 + m_2}\right)v_1 + \left(\frac{2m_2}{m_1 + m_2}\right)v_2$$

$$v_2^{'} = \left(\frac{2m_2}{m_1 + m_2}\right) v_1 + \left(\frac{m_2 - m_1}{m_1 + m_2}\right) v_2$$

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3- If the abject mass m_2 is at rest before the collision , verify that

$$v_1^{'} = \left(\frac{m_1 - m_2}{m_1 + m_2}\right) v_1 \qquad p_1^{'} = -\left(\frac{1 - \frac{m_1}{m_2}}{1 + \frac{m_1}{m_2}}\right) p_1$$

$$v_2^{'} = \left(\frac{2m_2}{m_1 + m_2}\right) v_1 \qquad p_2^{'} = -\left(\frac{2}{1 + \frac{m_1}{m_2}}\right) p_1$$

Describe the motion of the two bodies after the collisions based on the values of their masses $m_1; m_2$.

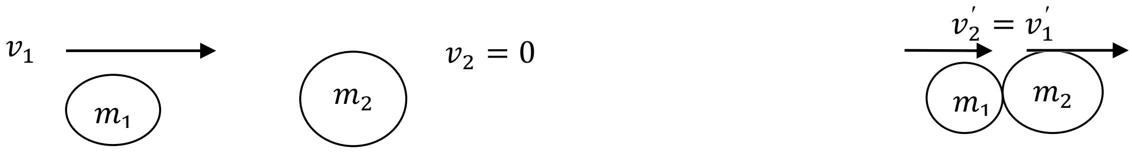
1.2. Inelastic collision

In an inelastic collision, the two objects stick together after the collision, forming a single object. Kinetic energy is not conserved in this type of collision, but momentum is still conserved

$$p_1^{'} + p_2^{'} = \overline{p_1} + \overline{p_2}$$

And consequently, the moment after the collision are:

$$p_1^{'} = -\left(\frac{1}{1 + \frac{m_2}{m_1}}\right) \overline{p_1} \qquad p_2^{'} = -\left(\frac{1}{1 + \frac{m_1}{m_2}}\right) \overline{p_1}$$



Manipulation

a- Elastic Collision

•Assemble the setup as shown in Figure -3-.

•Adjust the distance between the optical barriers so that the collision occurs between them.

•Before the collision, one of the carts, with a fixed mass of m_1 = 765 grams, is in motion while the other cart, with additional "m_s" masses, has a variable mass of $m_2 = m_{cart} + m_s = 265 + m_s$ grams and is at rest.

•When they pass through, the chronometer records the corresponding time "δt_1."

• After the collision, both carts in motion move in opposite directions, each passing through an optical barrier. The chronometer records two more passage times, "$\delta t'_1$" and "$\delta t'_2$."

• Repeat the previous steps while varying the mass of m_2 of the cart by adding additional masses.

m_2 (grs)	265	515	765	1015	1265
δt_1 (s)					
$\delta t'_1$ (s)					
$\delta t'_2$ (s)					
$v=\delta x/\delta t_1$ (m/s)					
$v'_1=\delta x/\delta t'_1$ (m/s)					
$v'_2=\delta x/\delta t'_2$ (m/s)					
$E_{c1}=m_1.v^2_1/2$ (J)					
$E'_{c1}=m_1.v'^2_1/2$ (J)					
$E'_{c2}=m_2.v'^2_2/2$ (J)					
$P_1=m_1.v_1$					
$P'_1=m_1.v'_1$					
$P'_2=m_2.v'_2$					
$(P_1+P_2)/(P'_1+P'_2)$					
$(E_{c1}+E_{c2})/(E'_{c1}+E'_{c2})$					

Notes:

•δ_t represents the time it takes for the tab, with a width of δ_x = 5mm, to pass through the optical barrier.

•After the collision, the first cart moves in the negative direction.

1- Complete the table.

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

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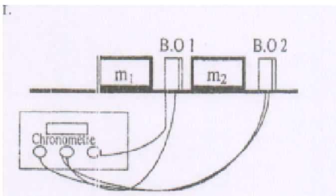

Figure-3-

a- Inelastic Collision

• Set up the experiment as shown in Figure 3.

• Adjust the distance between the optical barriers so that the collision occurs between them.

• Before the collision, one of the carts with a fixed mass of 205 grams is in motion, while the other cart, with additional "m_s" mass, has a variable mass of

$m_2 = m_{cart} + m_s = 265 + m_s$ grams and is at rest.

• When they pass through, the chronometer records the corresponding time "δ_t".

• After the collision, both carts in motion stick together and move in the same direction, passing through another optical barrier. Record the passage time on the table.

• Repeat the previous steps while varying the mass of m_2 of the cart by adding different masses of "m_s".

m_2 (grs)	265	515	765	1015	1265
δt_1 (s)					
δt_2 (s)					
$v=\delta x/ \delta t_1$ (m/s)					
$v'_1=\delta x/ \delta t_2= v'_2$ (m/s)					
$E_{c1}=m_1.v^2_1 /2$ (J)					
$E'_{c1}=m_1.v'^2_1 /2$ (J)					
$E'_{c2}=m_2.v'^2_2 /2$ (J)					
$P_1=m_1.v_1$					
$P'_1=m_1.v'_1$					
$P'_2=m_2.v'_2$					
$P_1+P_2/P'_1+P'_2$					
$E_{c1}+E_{c2}/E'_{c1}+ E'_{c2}$					

1- Fill in the table.
2-Based on the table's results, is there conservation of momentum and kinetic energy?
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Conclusion

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