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Faculty of sciences - common Basic of matter sciences

5th PRACTICAL WORK: ELASTIC AND INELASTIC COLLISIONS IN ONE DIMENSION

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	First Name	Family name	Subgroup	Professor's name
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Purpose

The purpose of this experiment is to investigate the momentum and kinetic energy for elastic and inelastic collisions. The momentum and kinetic energy before the collision of two cars are compared with the momentum and kinetic energy after the collision by looking at a plot of these quantities versus time.

THEORETICAL REMINDER OF BASIC CONCEPTS

Elastic and inelastic collisions are key principles in classical mechanics and physics, offering valuable insights into how objects behave when they collide in one dimension. To comprehend these collisions, it's essential to have a strong understanding of momentum and kinetic energy conservation principles. This exploration delves into the mathematical foundation of one-dimensional elastic and inelastic collisions. n this section, we will introduce some important concepts in this experimental work

1- ***Momentum:*** *momentum is a vector physical quantity representing the amount of motion an object possesses and is calculated by multiplying the object's mass by its velocity, according to the equation* $\vec{p} = m\vec{v}$. *This important concept in physics allows us to understand how external forces affect the motion of an object by monitoring changes in its momentum over time, including both its value and direction.*

2- ***Kinetic energy:*** *Kinetic energy is a scalar physical quantity that represents the energy possessed by an object due to its motion. Its value depends on the mass* ($\mathbf{m}$) *of an object and its velocity* ($\boldsymbol{v}$) *and is calculated using the following formula:*

$$E_K = \frac{1}{2} m\, v^2$$

3- ***The Collision:*** *Elastic and inelastic collisions are two types of interactions that can occur between objects in physics, particularly in the context of collisions.*

3-1- Elastic Collision:

- ✓ *In an elastic collision, both kinetic energy and momentum are conserved.*
- ✓ *This means that the total kinetic energy of the system remains constant before and after the collision.*

3-2- Inelastic Collision:

- ✓ *In an inelastic collision, momentum is conserved, but kinetic energy is not.*
- ✓ *This means that the total momentum of the system remains constant, but some kinetic energy is transformed into other forms of energy.*

The key difference between these two types of collisions is the conservation of kinetic energy. In elastic collisions, kinetic energy is conserved, while in inelastic collisions, some kinetic energy is lost or transformed into other forms of energy

THEORETICAL PART

The experimental setup illustrated in Figure 1, where the two magnets are placed facing each other to create repulsion between them.

- *Put the cart B, with a velocity of $v_B = 0$ m/s, between the two optical barriers.*
- *Launch cart A with an initial velocity v_A toward cart B.*

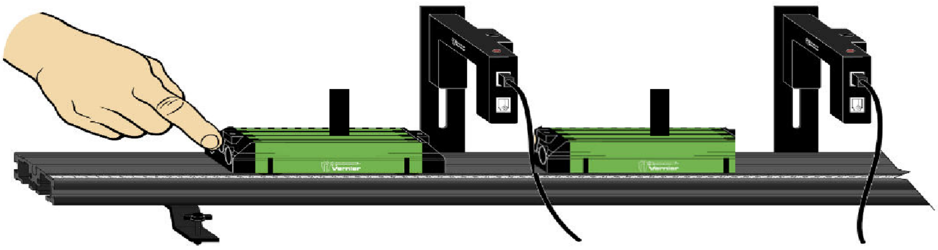


Figure 1

The two principles of conserving total kinetic energy and the principle of conserving total momentum before and after the collision in the case of an elastic collision in a single direction are described by the following two formulas:

$$\overrightarrow{P_{before}} = \overrightarrow{P'_{after}} \quad \Rightarrow \quad \overrightarrow{P_A} + \overrightarrow{P_B} = \overrightarrow{P'_A} + \overrightarrow{P'_B}$$

$$E_{K\,(before)} = E'_{K\,(after)} \quad \Rightarrow \quad E_{K_A} + E_{K_B} = E'_{K_A} + E'_{K_B}$$

- *Using these two relationships, demonstrate that the velocities of carts A and B after the collision, v'_A and v'_B, are expressed in terms of m_A, m_B, and v_A in the following form:*

$$v'_A = \frac{m_A - m_B}{m_A + m_B}\, v_A \qquad\qquad v'_B = \frac{2\, m_A}{m_A + m_B}\, v_A$$

- *Based on the mass values of the carts, discuss the direction of each cart after the collision.*

PRACTICAL PART

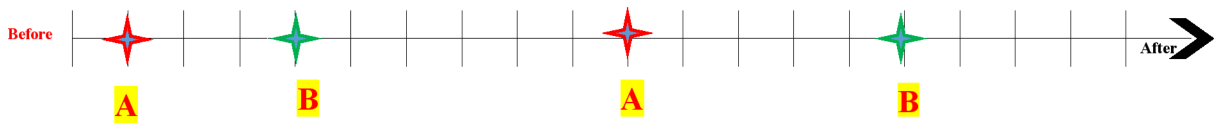
1) Elastic Collision

To conduct the experiment described in Figure 1, follow the steps below:

- *Ensure that the air track was level.*
- *Cart B was placed at rest between the optical barriers, and we attached the masses as specified in the tables to it.*
- *Cart A was then given an initial push to set it in motion.*
- *We carefully recorded the time taken δt during the experiment.*
- *Calculate the velocities of both carts before and after the collision.*
- *Draw momentum vectors on the axis provided below for both mobiles A and B before and after the collision using an appropriate scale.*

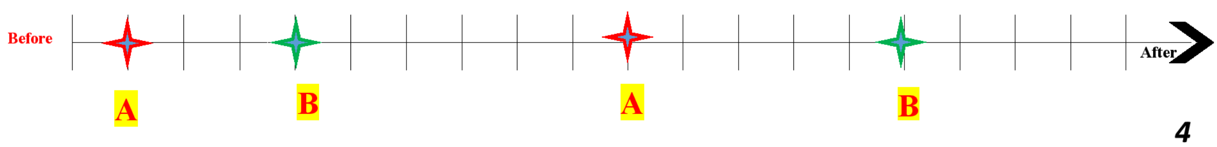
$m_A = m_B = \dots\dots\dots$ Kg				
	Before collision		After collision	
	cart A	cart B	cart A	cart B
δt_i	$\delta t_A =$		$\delta t'_A =$	$\delta t'_B =$
$\lVert\vec{v_i}\rVert = \dfrac{\delta x}{\delta t_i}$	$v_A =$	$v_B = 0\ m/s$	$v'_A =$	$v'_B =$
$\lVert\vec{P_i}\rVert = m_i \times \lVert\vec{v_i}\rVert$				
$E_{k,i} = \dfrac{1}{2} m_i \times \lVert\vec{v_i}\rVert^2$				
$P_{total} = \sum \lVert\vec{P_i}\rVert$				
$E_{K,total} = \sum E_{k,i}$				

Scale: ... ...



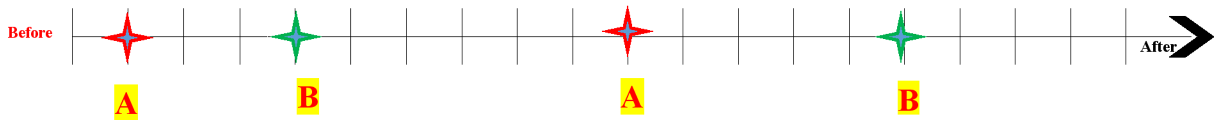
($m_A > m_B$) $m_A = \dots\dots\dots$ Kg $m_B = \dots\dots\dots$ Kg				
	Before collision		After collision	
	cart A	cart B	cart A	cart B
δt_i	$\delta t_A =$		$\delta t'_A =$	$\delta t'_B =$
$\lVert\vec{v_i}\rVert = \dfrac{\delta x}{\delta t_i}$	$v_A =$	$v_B = 0\ m/s$	$v'_A =$	$v'_B =$
$\lVert\vec{P_i}\rVert = m_i \times \lVert\vec{v_i}\rVert$				
$E_{k,i} = \dfrac{1}{2} m_i \times \lVert\vec{v_i}\rVert^2$				
$P_{total} = \sum \lVert\vec{P_i}\rVert$				
$E_{K,total} = \sum E_{k,i}$				

Scale: ... ...



($m_A < m_B$) $m_A =$ ……… Kg $m_B =$ ……… Kg				
	Before collision		After collision	
	cart A	cart B	cart A	cart B
δt_i	$\delta t_A =$		$\delta t'_A =$	$\delta t'_B =$
$\lVert\vec{v_i}\rVert = \frac{\delta x}{\delta t_i}$	$v_A =$	$v_B = 0\ m/s$	$v'_A =$	$v'_B =$
$\lVert\vec{P_i}\rVert = m_i \times \lVert\vec{v_i}\rVert$				
$E_{k,i} = \frac{1}{2} m_i \times \lVert\vec{v_i}\rVert^2$				
$P_{total} = \sum \lVert\vec{P_i}\rVert$				
$E_{K,total} = \sum E_{k,i}$				

Scale: … … … … … … … … .



2) Inelastic Collision

Within this part, we will replicate the previous experiment, but this time, we will substitute the magnets with Velcro strips. Following the collision, both mobiles will adhere together and maintain their motion at an identical velocity and in the same direction.

Measure the velocities before and after the collision using the digital counter, then fill in the following tables:

$m_A = m_B =$ ……… Kg				
	Before collision		After collision	
	cart A	cart B	cart A	cart B
δt_i	$\delta t_A =$		$\delta t'_A =$	$\delta t'_B =$
$\lVert\vec{v_i}\rVert = \frac{\delta x}{\delta t_i}$	$v_A =$	$v_B = 0\ m/s$	$v'_A = v'_B =$	
$\lVert\vec{P_i}\rVert = m_i \times \lVert\vec{v_i}\rVert$				
$E_{k,i} = \frac{1}{2} m_i \times \lVert\vec{v_i}\rVert^2$				
$P_{total} = \sum \lVert\vec{P_i}\rVert$				
$E_{K,total} = \sum E_{k,i}$				

($m_A > m_B$) $m_A =$ ……… Kg $m_B =$ ……… Kg				
	Before collision		After collision	
	cart A	cart B	cart A	cart B
δt_i	$\delta t_A =$		$\delta t'_A =$	$\delta t'_B =$
$\lVert\vec{v_i}\rVert = \frac{\delta x}{\delta t_i}$	$v_A =$	$v_B = 0\ m/s$	$v'_A = v'_B =$	
$\lVert\vec{P_i}\rVert = m_i \times \lVert\vec{v_i}\rVert$				
$E_{k,i} = \frac{1}{2} m_i \times \lVert\vec{v_i}\rVert^2$				
$P_{total} = \sum \lVert\vec{P_i}\rVert$				
$E_{K,total} = \sum E_{k,i}$				

$(m_A < m_B)$ $m_A =$ ……… Kg $m_B =$ ……… Kg				
	Before collision		*After collision*	
	cart A	*cart B*	*cart A*	*cart B*
δt_i	$\delta t_A =$		$\delta t'_A =$	$\delta t'_B =$
$\Vert\vec{v_i}\Vert = \frac{\delta x}{\delta t_i}$	$v_A =$	$v_B = 0\ m/s$	$v'_A = v'_B =$	
$\Vert\vec{P_i}\Vert = m_i \times \Vert\vec{v_i}\Vert$				
$E_{k,i} = \frac{1}{2} m_i \times \Vert\vec{v_i}\Vert^2$				
$P_{total} = \sum \Vert\vec{P_i}\Vert$				
$E_{K,total} = \sum E_{k,i}$				

- *In each case, compare the total linear momentum and the total kinetic energy of the system before and after the collision*

- ***What is the conclusion from this practical work?***