PHYSICS INVESTIGATION
IB PHYSICS SL

What is the relation between the alacrity and different materials in the elastic and inelastic collision, what is the effect of the materials?

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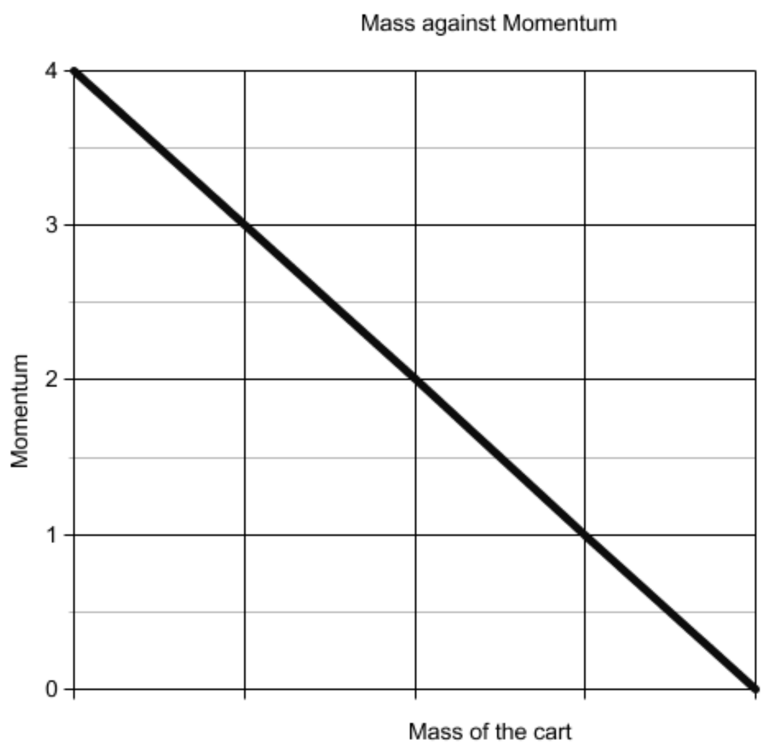
INTRODUCTION

In this laboratory I'm going to measure different speeds after elastic and inelastic collisions. Moreover, this laboratory will also focus on the measurement of the different energies absorbed after elastic and inelastic collisions.

Consequently, the aim of the experiment is to investigate the relation between the alacrity and different materials in the elastic and inelastic collision. This will be done by changing the mass of a cart, and then by using the different materials in the elastic and inelastic collision.

VARIABLES

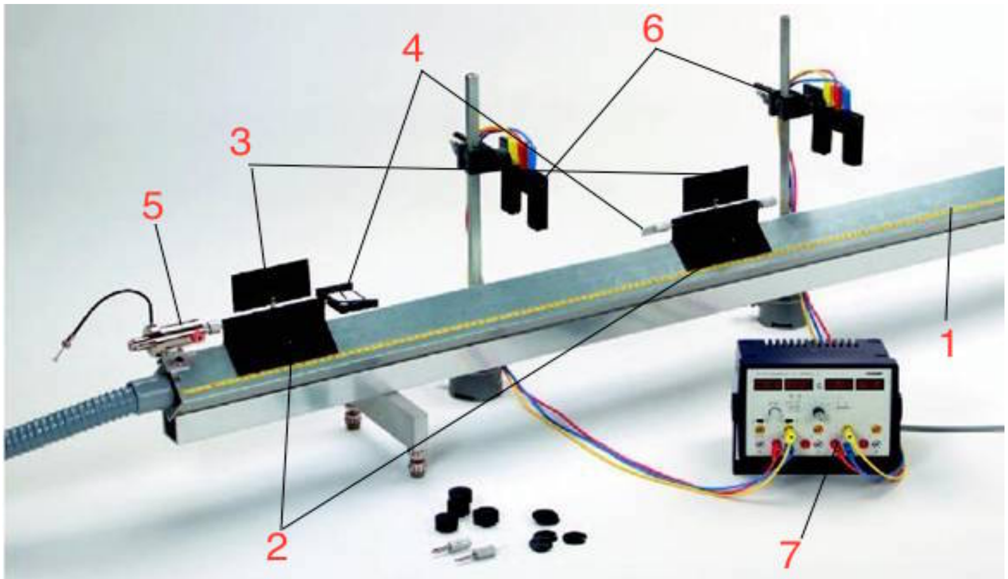


- The independent variable is the mass of the trolley
- The dependent variable is the momentum, which depends on the certain type of the collision as well as on the type of the materials used in the inelastic or elastic collision.

APPARATUS

- 1-rail
- 2-trolleys
- 3-flat plates
- 4-plugs
- 5-launch pad
- 6-light barriers

- 7-instrument
- rubber and plastic plate - in order to see the **elastic collision**
- needle and plug - in order to see the **inelastic collision**



The experimental apparatus is a rail, on which two carts can move almost without friction. At the sides of the two carts there are inserted plates of a certain length 10 cm. Plugs of different types can be attached to the ends of the carts: Rubber and plastic plate - in order to see the **elastic collision**; Needle and plug - in order to see the **inelastic collision.** At the left side of the first cart you can see a starting system, which can be used to create speed for the first cart. This start system allows you to select three values of speed. At the top of of the rail there are two devices called light barriers. They consist of a light source and a light receiver. When the cart goes through this light barrier, it covers a ray of light for a while, which gives light barrier an opportunity to measure the speed of the cart for specific time. This time can be measured and hence help to determine the speed of the cart.
Light barriers are connected to the timer. The instrument has 4 displays, on which I can see the time for the left and right cart and for the movement forward and backwards. Using this time, I can calculate the velocity of each carriage before and after the elastic and inelastic collision.

ELASTIC COLLISION

Given numbers:
$\underset{Vinitial1}{\longrightarrow}$ and $\underset{Vinitial2}{\longrightarrow}$ - are the speeds of the two carts before the elastic collision
$\underset{v1}{\rightarrow}$ and $\underset{v2}{\rightarrow}$- are the speed after the carts had an elastic collision

Formulas used:

Momentum conservation law and the law of conservation of energy

$$m_1 \underset{Vinitial1}{\longrightarrow} + m_2 \underset{Vinitial2}{\longrightarrow} = (m_1 + m_2) \underset{v_{final}}{\longrightarrow}$$

$$\frac{m_1 \overrightarrow{Vinitial1}^2}{2} + \frac{m_2 \overrightarrow{Vinitial2}^2}{2} = \frac{m_1 \overrightarrow{v_1}^2}{2} + \frac{m_2 \overrightarrow{v_2}^2}{2}$$

In order to get the speeds of v1 and v2 we can can use the momentum conservation law.

$$\overrightarrow{v_1} = \frac{2m_1 \overrightarrow{Vinitial2} + (m_1 - m_2)\overrightarrow{Vinitial1}}{m_1 + m_2}$$

$$\overrightarrow{v_2} = \frac{2m_1 \overrightarrow{Vinitial1} + (m_2 - m_1)\overrightarrow{Vinitial2}}{m_1 + m_2}$$

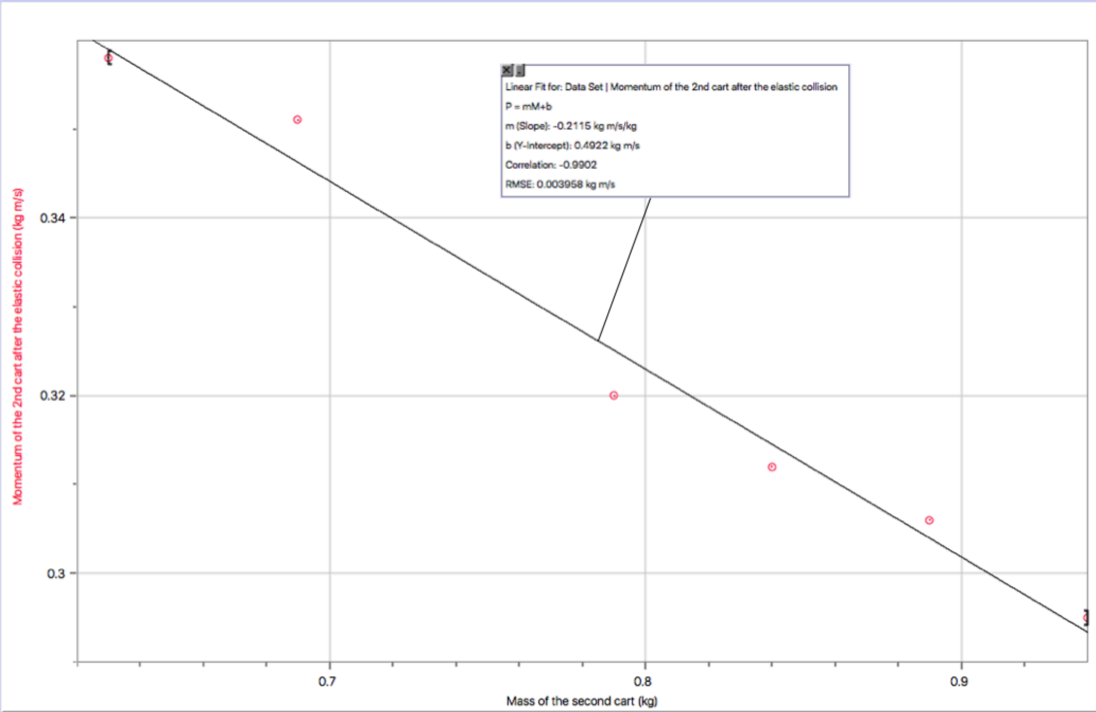
Using the experimental apparatus, I got these numbers and recorded them to these tables.

t1initial s	t1 s	t2 s	$\overrightarrow{Vinitial_1}$ m/s	$\overrightarrow{v_1}$ m/s	$\overrightarrow{v_2}$ m/s
0,169	0,378	0,189	0,627	0,28	0,568
0,171	0,798	0,214	0,622	0,26	0,509
0,173	0,593	0,264	0,614	0,181	0,404
0,186	0,535	0,287	0,569	0,21	0,371
0,176	0,556	0,309	0,61	0,193	0,344
0,169	0,419	0,314	0,63	0,254	0,338

m1 kg	m2 kg	P1initial kg m/s	P1 kg m/s	P2 kg m/s	P2-P1 kg m/s	W1initial J	W1 J	W2 J	W2+1 J
0,39	0,63	0,245	0,109	0,358	0,249	0,076	0,015	0,102	0,117
0,39	0,69	0,242	0,101	0,351	0,25	0,075	0,0131	0,089	0,102
0,39	0,79	0,239	0,071	0,32	0,249	0,074	0,006	0,065	0,071
0,39	0,84	0,222	0,082	0,312	0,23	0,063	0,009	0,058	0,067
0,39	0,89	0,234	0,075	0,306	0,23	0,072	0,007	0,053	0,0537
0,39	0,94	0,245	0,099	0,295	0,196	0,077	0,013	0,054	0,067

1st graph.

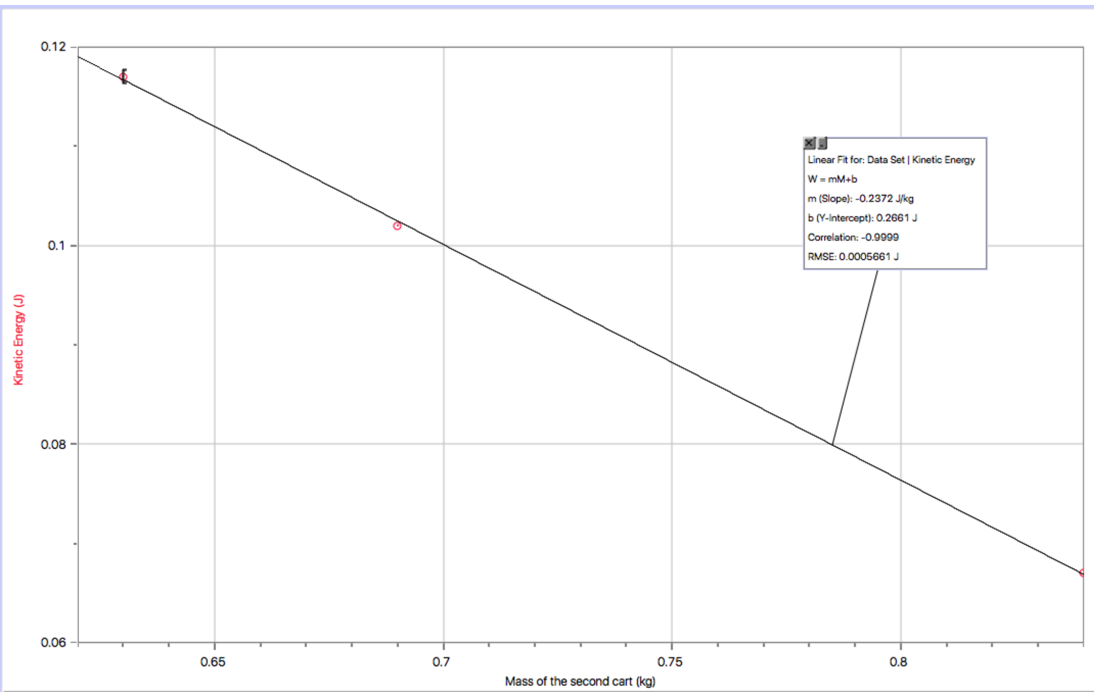
Data Set	
M (kg)	P (kg m/s)
0.63	0.358
0.69	0.351
0.79	0.32
0.84	0.312
0.89	0.306
0.94	0.295



The following graph shows that mass is an independent variable, and momentum of the second cart is a dependent variable. Through this graph we can see that it's decreasing as the slope is negative. The variables for the mass increase, consequently we see a decrease in the momentum.

2nd graph.

Data Set	
M (kg)	W (J)
0.63	0.117
0.69	0.102
0.79	0.071
0.84	0.067
0.89	0.0537
0.94	0.067



On that graph you can see a relationship between the mass of the second cart and the total kinetic energy involved in the whole lab. The bigger the mass gets the less kinetic energy in total. Through this graph we can also see that the slope is also negative. The variables for the mass decrease, consequently there is a a decrease in the kinetic energy, that directs us to the conclusion that the energy is lost during the elastic collision.

INELASTIC COLLISION

Given numbers:

m_1, m_2 – are the weights of the two carts.
$\underrightarrow{Vinitial1}$ and $\underrightarrow{\text{Vinitial}_2}$ $-$ are the speeds of the two carts before the inelastic collision.
$\underrightarrow{v_{final}}$ is the speed after the carts had an inelastic collision.

Formulas used:

Momentum conservation law

$$m_1 \underrightarrow{Vinitial1} + m_2 \underrightarrow{Vinitial2} = (m_1 + m_2) \underrightarrow{v_{final}}$$

$$\underrightarrow{v_{final}} = \frac{m_1 \underrightarrow{Vinitial1} + m_2 \underrightarrow{Vinitial2}}{m1 + m2}$$

All of this might be calculated using the scalar expression, which can be used to show the path, way of the cart. Plus (+) sign can be used to show that the carts are going in one direction, while Minus (-) sign can be used to show that the carts are going in the direction from each other.

$$\underrightarrow{v_{final}} = \frac{m_1 \underrightarrow{Vinitial1} \mp m_2 \underrightarrow{Vinitial2}}{m1 + m2}$$

It's also interesting to know, that the amount of the mechanical energy, which transformed into the internal energy, equals in amount to the energy difference before and after inelastic collision: «**Mechanical energy** is the sum of potential **energy** and kinetic **energy**. »

$$Mechanical\ Energy = Kinetic\ energy + Potential\ energy$$

$$Mechanical\ Energy = \frac{1}{2}mv^2 + mgh$$

$$Q = (W_{initial1} + W_{initial2}) - W_{final} = \frac{m_1 \underrightarrow{Vinitial1}^2}{2} + \frac{m_2 \underrightarrow{Vinitial2}^2}{2} - \frac{(m_1 + m_2){v_{final}}^2}{2}$$

m1 kg	m2 kg	L(distance) m	t1initial s	t s	$\overrightarrow{\text{Vinitial}_1}$ m/s	$\overrightarrow{vfinal}$ m/s
0,39	0,44	0,1	0,164	0,318	0,625	0,292
0,39	0,49	0,1	0,17	0,334	0,614	0,243
0,39	0,54	0,1	0,161	0,321	0,622	0,26
0,39	0,59	0,1	0,169	0,325	0,634	0,252
0,39	0,64	0,1	0,168	0,325	0,611	0,23
0,39	0,69	0,1	0,169	0,326	0,603	0,225

m1 kg	m2 kg	m2/m1	p1initial kg m/s	W1initial J	W J	Q J
0,39	0,44	1,13	0,244	0,076	0,038	0,038
0,39	0,49	1.3	0,24	0,074	0,033	0,05
0,39	0,54	1.4	0,243	0,075	0,0365	0,047
0,39	0,59	1.51	0,247	0,078	0,03	0,04
0,39	0,64	1.64	0,238	0,073	0,027	0,032
0,39	0,69	1.77	0,235	0,071	0,025	0,037

Joules Graph -

CONCLUSION

During **inelastic collision** kinetic energy is completely or partially converted into internal energy, leading to a rise in temperature of the bodies. After impact, a colliding body move together at the same speed or at rest. In this case, after the impact bodies move together. When inelastic collision is performed only the law of conservation of momentum is working.

When there is a completely **elastic collision** kinetic energy of the colliding bodies passes first into the potential energy of elastic deformation. Then, the body is back to its original shape, pushing each other. As a result, the potential energy of elastic deformation is again converted into kinetic energy, and body flies at speed, the magnitude and direction of which is determined by two laws - the law of conservation of energy and momentum conservation law.