T.C.

GEBZE TECHNICAL UNIVERSITY

PHYSICS DEPARTMENT

PHYSICS LABORATORY I

EXPERIMENT REPORT

THE NAME OF THE EXPERIMENT

Two Dimensional Collisions

PREPARED BY

NAME AND SURNAME:

STUDENT NUMBER :

DEPARTMENT :

Experimental Procedure:

Experiment set-up of elastic collision in two dimension is given in Figure 4.1 Thanks to the table which friction is decreased as fully as possible via compressor, momentum and mechanical energy of two discs will be investigated.

Figure 4.1: Experiment set-up of elastic collision in two dimension.

There are two pedals wired to the table; one works as arc generator and other one decreases friction of table. Motion paths of the discs are identified by means of arc generator leaves marks on the paper.

Detailed process of the experiment is given below, please follow the instructions.

1. Make sure that the table has horizontal position.
2. Place a carbon paper and a white paper on the platform, respectively.
3. Open the arc counter and set frequency. f : _____ s^{-1}
4. Measure the weight of the discs. m_1 :_____ gr; m_2 :_____ gr

Warning: ***Make several tests before start to get proper collision angle without arc generation.***

5. Use only compressor pedal for tests and collide by gently dragging.

Warning: ***During use of arc generator do not touch metal parts of the experiment set-up such as discs and sides of the platform.***

6. After tests, perform the experiment with using both compressor and arc generator. As a result, marks will form on the back side of the paper through moving paths of discs.
7. Close arc generator and lift the discs off the platform after the experiment.

To investigate the momentum and energy conservation, velocities of discs before and after the collision should be determined. Please follow steps below;

i. Specify motion paths leaved by discs on paper as before and after collision (Figure 4.2 and 4.3).

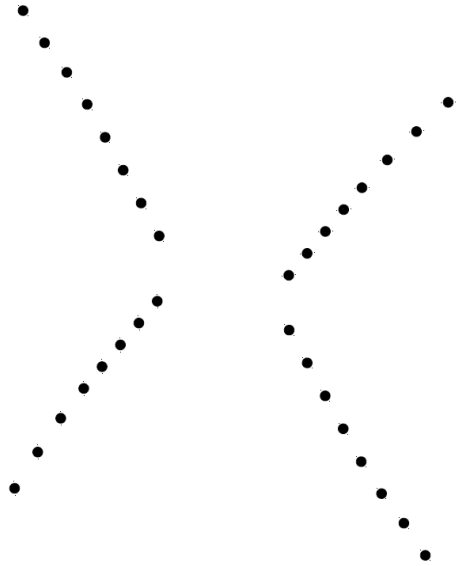

Figure 4.2

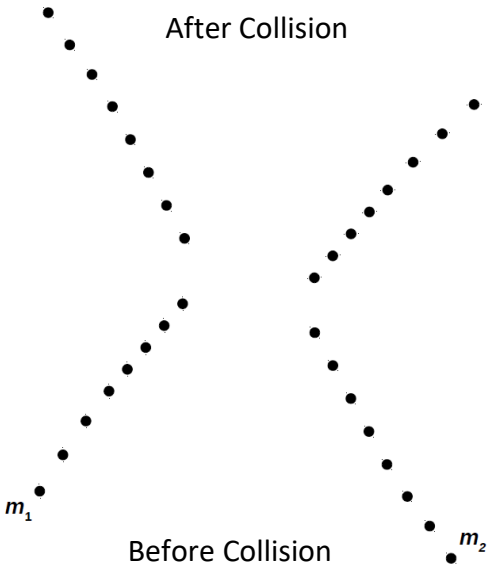

Figure 4.3

ii. Form a linear line using 4 or 5 points for each discs before and after the collision points as shown in Figure 4.4. The points of intersecting lines are collision points (Figure 4.5).

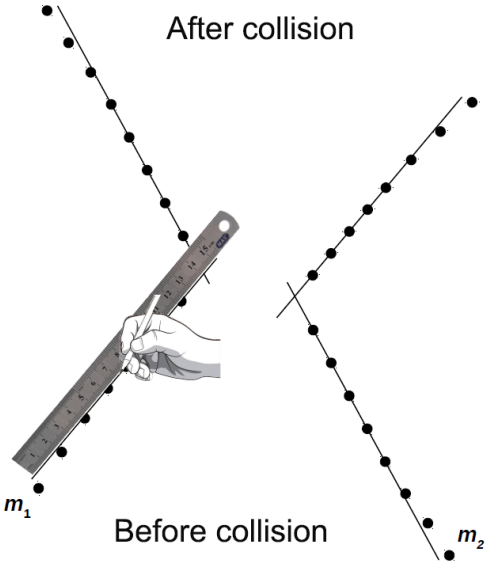

Figure 4.4

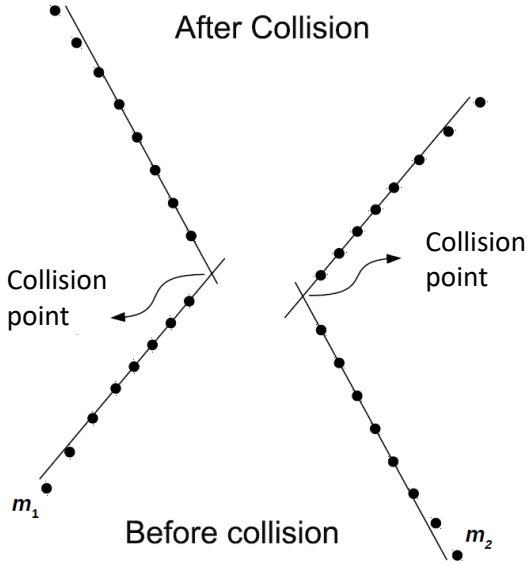

Figure 4.5

iii. Draw a line which combine the points of collision and identify as x-axis as shown in Figure 4.6. Then, draw a y-axis perpendicular to the x-axis (Figure 4.7).

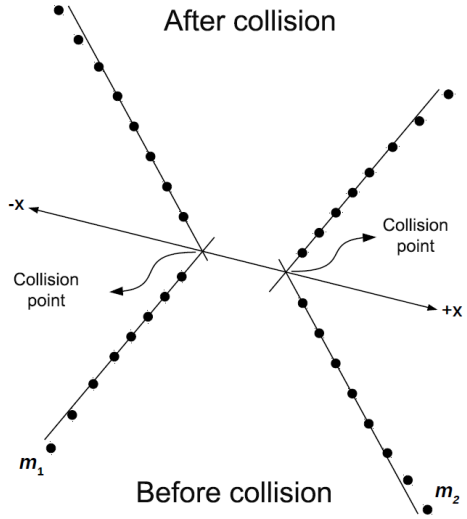

Figure 4.6

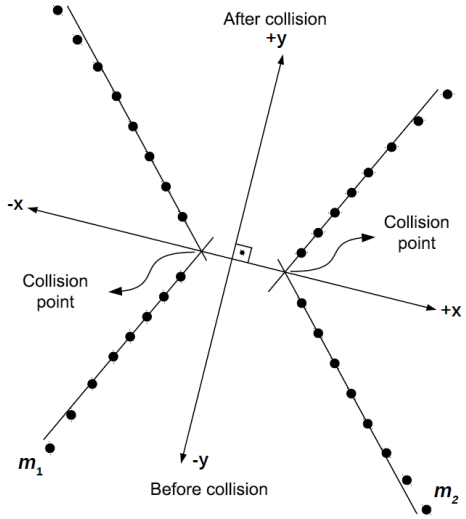

Figure 4.7

iv. Enumerate before and after the collision points which have same time interval (Figure 4.8).

v. Specify projections first and last points of the discs, which mean displacement of the discs Δx and Δy, on x- and y-axis as shown in Figure 4.9. Please note the displacement values on Table 4.1 and 4.2.

Warning: Displacement is a vector quantity. Thus, please consider +/– *directions.*

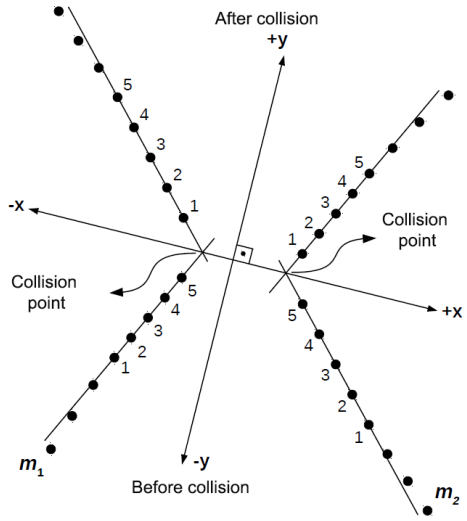

Figure 4.8

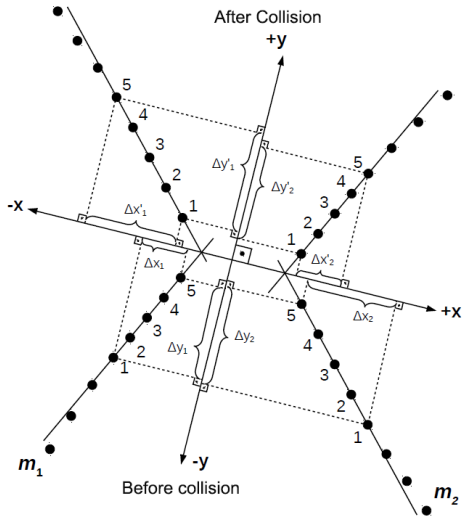

Figure 4.9

vi. Calculate the elapsed time between consecutive two points, which means period (T), using frequency (f) of arc generator.

$T = \frac{1}{f} =$_____ (s)

vii. Calculate the elapsed time of displacement using number of gaps (*n*) and period (*T*) .

$\Delta t = nT =$ _____ (s)

viii. Calculate velocities for each disc using Δx, Δy and Δt values calculated before. Then, calculate kinetic energies and vector components of momentum using calculated velocity and weight.

Warning: *Displacement, velocity and momentum are vector quantities, thus consider direction of the calculated values. Please give calculated results with units.*

Table 4.1. Before collision

	Δx (_____)	**Δy (_____)**
m_1		
m_2		

$v_{1x} = \frac{\Delta x_1}{\Delta t} =$

$v_{1y} = \frac{\Delta y_1}{\Delta t} =$

$v_1 = \sqrt{v_{1x}^2 + v_{1y}^2} =$

$P_{1x} = m_1 v_{1x} =$

$P_{1y} = m_1 v_{1y} =$

$E_1 = \frac{1}{2} m_1 v_1^2 =$

$v_{2x} = \frac{\Delta x_2}{\Delta t} =$

$v_{2y} = \frac{\Delta y_2}{\Delta t} =$

$v_2 = \sqrt{v_{2x}^2 + v_{2y}^2} =$

$P_{2x} = m_2 v_{2x} =$

$P_{2y} = m_2 v_{2y} =$

$E_2 = \frac{1}{2} m_2 v_2^2 =$

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Table 4.2. After collision

	$\Delta x'$ (____)	$\Delta y'$ (____)
m_1		
m_2		

$v'_{1x} = \frac{\Delta x'_1}{\Delta t} =$

$v'_{1y} = \frac{\Delta y'_1}{\Delta t} =$

$v'_1 = \sqrt{v'^2_{1x} + v'^2_{1y}} =$

$P'_{1x} = m_1 v'_{1x} =$

$P'_{1y} = m_1 v'_{1y} =$

$E'_1 = \frac{1}{2} m_1 {v_1}'^2 =$

$v'_{2x} = \frac{\Delta x'_2}{\Delta t} =$

$v'_{2y} = \frac{\Delta y'_2}{\Delta t} =$

$v'_2 = \sqrt{v'^2_{2x} + v'^2_{2y}} =$

$P'_{2x} = m_2 v'_{2x} =$

$P'_{2y} = m_2 v'_{2y} =$

$E'_2 = \frac{1}{2} m_2 v'^2_2 =$

Conservation of momentum and kinetic energy: Conservation equations of momentum and kinetic energy for x- and y- axis are given in Eq. 4.15-4.17. As a result, please check whether the energy and momentum are conserved.

i. Momentum-horizontal :$m_1 v_{1x} + m_2 v_{2x} = m_1 v'_{1x} + m_2 v'_{2x} \Rightarrow P_{1x} + P_{2x} = P'_{1x} + P'_{2x}$

ii. Momentum-vertical:$m_1 v_{1y} + m_2 v_{2y} = m_1 v'_{1y} + m_2 v'_{2y} \Rightarrow P_{1y} + P_{2y} = P'_{1y} + P'_{2y}$

iii. Kinetic energy :$\frac{1}{2} m_1 v_1^2 + \frac{1}{2} m_2 v_2^2 = \frac{1}{2} m_1 v'^2_1 + \frac{1}{2} m_2 v'^2_2 \Rightarrow E_1 + E_2 = E'_1 + E'_2$

Calculate the loss using total kinetic energies of the discs before and after the collision.

$$\%loss\ of\ kinetic\ energy = \frac{|(E_1 + E_2) - (E'_1 + E'_2)|}{E_1 + E_2} \times 100 =$$

Please explain whether momentums and energies have changed before and after the collision? Why?

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Movement of center of mass:

i. According to the Figure 4.9, connect the dots to form a line before and after the collision (as seen in Figure 4.10). Center of mass is midpoint of the line connect two discs due to equality of masses (m_1=m_2). Mark the midpoints of these lines (as seen in Figure 4.11).

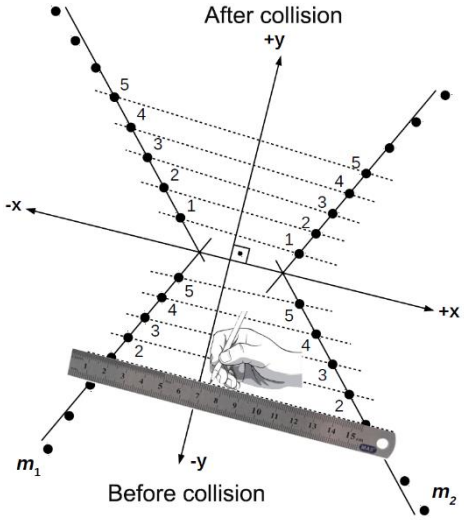

Figure 4.10

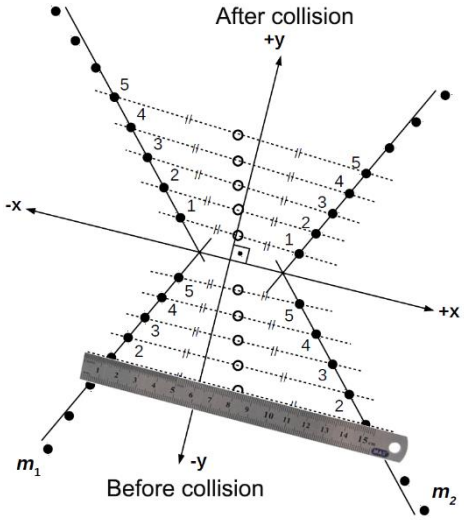

Figure 4.11

ii. By using a ruler, draw a line on these midpoints (Figure 4.12). These two lines are direction of center of mass (CM). Measure the displacements of CM (ΔS_{CM} ve $\Delta S'_{CM)}$ for before and after the collision as seen in Figure 4.13.

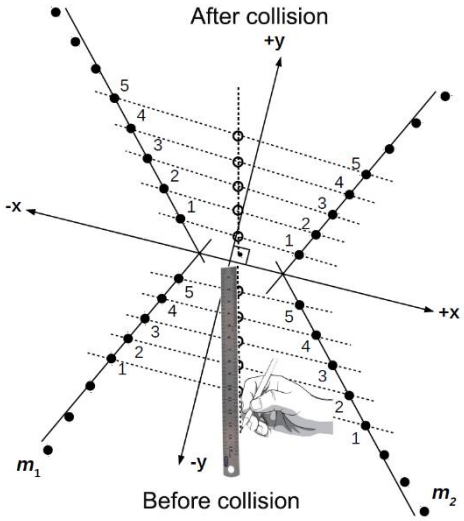

Figure 4.12

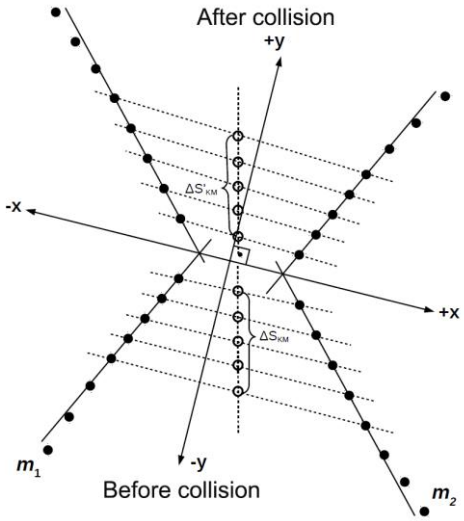

Figure 4.13

iii. Claculate elapsed time for displacement of CM according to the equation below;

$\Delta t = nT =$ _____ (s)

iv. Calculate velocities of CM using the equations; $\Delta S_{CM}/\Delta t$ *and* $\Delta S'_{CM}/\Delta t$. Calculate momentum and kinetic energies using calculated velocities and total weight.

Please give calculated results with units..

Table 4.3: Center of mass

	ΔS_{CM} (____)	$\Delta S'_{CM}$ (____)
$M = m_1+m_2 =$		

$V_{CM} = \frac{\Delta S_{CM}}{\Delta t} =$

$P_{KM} = MV_{CM} =$

$E_{KM} = \frac{1}{2}MV_{CM}^2 =$

$V'_{CM} = \frac{\Delta S'_{CM}}{\Delta t} =$

$P'_{CM} = MV'_{CM} =$

$E'_{CM} = \frac{1}{2}MV'^2_{CM} =$

Momentum of center of mass and conservation of kinetic energy: Please check whether the energy and momentum for CM are conserved using equations given below.

i. Momentum: $MV_{CM} = MV'_{CM} \Rightarrow P_{CM} = P'_{CM}$

ii. Kinetic energy: $\frac{1}{2}MV_{CM}^2 = \frac{1}{2}MV'^2_{CM} \Rightarrow E_{CM} = E'_{CM}$

Calculate the loss using total kinetic energies of the CM before and after the collision.

$$\%\ loss\ of\ kinetic\ energy = \frac{|E_{CM} - E'_{CM}|}{E_{CM}} \times 100 =$$

Please explain is there any change in the energy and momentum of CM before and after the collision, and has the direction of motion of the CM changed?

_____

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Conclusion, Comment and Discussion:

(Tips: Give detail explanation about what you've learned in the experiment and also explain the possible errors and their reasons.)

Questions:

1) Show total momentum is conserved in a closed particle system?

2) Give two examples for inelastic collision?

Signature: