PH160: Laboratory 2: Collision and Conservation of Momentum

Experiment 1: Elastic and Inelastic Collision

Aim -: To demonstrate the collision behaviour for elastic and inelastic collisions and to study the variation of momentum, kinetic energy and velocity of the colliding objects before and after the collision.

Theory -: The laws of conservations used in the experiment are:

1. Law of Conservation of Momentum -: It states that the total momentum of a system will remain conserved if there is no external force acting on the system.
2. Law of Conservation of Energy -: This law states that energy can neither be created nor be destroyed, it can only be transformed from one form to another.

Collision is the abrupt change in path of a body due to its interaction with another body (or bodies). As no external force acts on the system during collision, the net momentum of the system remains conserved. There are two types of collisions:

1. Elastic Collision -: The collision in which both the total momentum and the total kinetic energy remain conserved are elastic collisions. Coefficient of Restitution for such a collision is unity.
2. Inelastic Collision -: The collision in which the total momentum remains conserved but the total kinetic energy does not are inelastic collisions. The value of coefficient of restitution for inelastic collision is between zero and unity (including zero and excluding unity).

Formulae Used -: The momentum and kinetic energy of a body is given by,

$$\vec{p} = m\vec{v}$$

$$K.E. = \frac{1}{2}mv^2$$

where m is the mass of body and v is its velocity.

The Coefficient of Restitution of a collision is given by,

$$e = \frac{v_2' - v_1'}{v_1 - v_2}$$

where v_2' and v_1' are velocities of the colliding objects after the collision and v_1 and v_2 are velocities of the objects before the collision.

Elastic Collision -: In an elastic collision, the total momentum as well as total kinetic energy remains constant, i.e.

$$m_1\overrightarrow{v_1} + m_2\overrightarrow{v_2} = m_1\overrightarrow{v_1'} + m_2\overrightarrow{v_2'}$$

PH160: Laboratory 2: Collision and Conservation of Momentum

$$\frac{1}{2}m_1v_1^2 + \frac{1}{2}m_2v_2^2 = \frac{1}{2}m_1v_1'^2 + \frac{1}{2}m_2v_2'^2$$

Solving for v_1' and v_2',

$$v_1' = \frac{m_1-m_2}{m_1+m_2}v_1 + \frac{2m_2}{m_1+m_2}v_2$$

$$v_2' = \frac{2m_1}{m_1+m_2}v_1 + \frac{m_2-m_1}{m_1+m_2}v_2$$

Inelastic Collision -: In an inelastic collision, the total momentum remains conserved but the total kinetic energy does not remain constant.

$$m_1\overrightarrow{v_1} + m_2\overrightarrow{v_2} = m_1\overrightarrow{v_1'} + m_2\overrightarrow{v_2'}$$

Since we can't apply conservation of kinetic energy, we use coefficient of restitution for finding v_1' and v_2',

$$e = \frac{v_2' - v_1'}{v_1 - v_2}$$

Solving for v_1' and v_2',

$$v_1' = \frac{m_1-em_2}{m_1+m_2}v_1 + \frac{(1+e)m_2}{m_1+m_2}v_2$$

$$v_2' = \frac{(1+e)m_1}{m_1+m_2}v_1 + \frac{m_2-em_1}{m_1+m_2}v_2$$

Observations -:

Performing the experiment in the simulator gave following observations.

Table 1: For coefficient of restitution equal to 1.

Sr. No.	Mass (kg)	Before Collision				After Collision			
		Velocities (m/s)	Momentum (kg. m/s)	Net Momentum p = $p_1 + p_2$	Kinetic Energy (J)	Velocities (m/s)	Momentum (kg. m/s)	Net Momentum p = $p_1 + p_2$	Total Kinetic Energy (J)
1.	m_1= 3 m_2= 3	$v_1 = 23$ $v_2 = 23$	$p_1 = 69$ $p_2 = 69$	138	KE_1 = 793.5 KE_2 = 793.5 KE_T = 1587	$v_1' =$ -- $v_2' =$ --	$p_1' =$ -- $p_2' =$ --	--	KE_1' = -- KE_2' = -- KE_T' = --

PH160: Laboratory 2: Collision and Conservation of Momentum

2.	m_1= 3 m_2= 4	$v_1 = 28$ $v_2 = 28$	$p_1 = 84$ $p_2 = 112$	196	KE_1 = 1176 KE_2 = 1568 KE_T = 2744	$v_1' =$ -- $v_2' =$ --	$p_1' =$ -- $p_2' =$ --	--	KE_1' = -- KE_2' = -- KE_T' = --
3.	m_1= 2 m_2= 2	$v_1 = 55$ $v_2 = 20$	$p_1 = 110$ $p_2 = 40$	150	KE_1 = 3025 KE_2 = 400 KE_T = 3425	$v_1' = 20$ $v_2' = 55$	$p_1' = 40$ $p_2' = 110$	150	KE_1' = 400 KE_2' = 3025 KE_T' =3425
4.	m_1= 4 m_2= 5	$v_1 = 70$ $v_2 = 24$	$p_1 = 280$ $p_2 = 120$	400	KE_1 = 9800 KE_2 = 1440 KE_T = 11240	$v_1' = 19$ $v_2' = 65$	$p_1' = 76$ $p_2' = 324$	400	KE_1' = 714 KE_2' =10526 KE_T' =11240

In case first and second no collision occurs because the velocities of the objects are same.

Table 2: For coefficient of restitution equal to 0.6

Sr. No.	Mass (kg)	**Before Collision**				**After Collision**			
		Velocities (m/s)	Momentum (kg. m/s)	Net Momentum p = $p_1 + p_2$	Kinetic Energy (J)	Velocities (m/s)	Momentum (kg. m/s)	Net Momentum p = $p_1 + p_2$	Kinetic Energy (J)
1.	m_1 = 2 m_2 = 2	$v_1 = 50$ $v_2 = 50$	$p_1 = 100$ $p_2 = 100$	200	KE_1 = 2500 KE_2	$v_1' =$ -- $v_2' =$ --	$p_1' =$ -- $p_2' =$ --	--	KE_1' = -- KE_2'

					= 2500 KE_T = 5000				= -- KE'_T = --
2.	m_1 = 2 m_2 = 4	$v_1 = 64$ $v_2 = 64$	$p_1 = 128$ $p_2 = 256$	384	KE_1 = 4096 KE_2 = 8192 KE_T =12288	v'_1 = -- v'_2 = --	p'_1 = -- p'_2 = --	--	KE'_1 = -- KE'_2 = -- KE'_T = --
3.	m_1 = 4 m_2 = 4	$v_1 = 75$ $v_2 = 65$	$p_1 = 300$ $p_2 = 260$	560	KE_1 =11250 KE_2 =8450 KE_T =19700	$v'_1 = 67$ $v'_2 = 73$	$p'_1 = 268$ $p'_2 = 292$	560	KE'_1 = 8978 KE'_2 =10658 KE'_T =19636
4.	m_1 = 3 m_2 = 5	$v_1 = 50$ $v_2 = 32$	$p_1 = 150$ $p_2 = 160$	310	KE_1 = 3750 KE_2 = 2560 KE_T = 6310	$v'_1 = 32$ $v'_2 = 43$	$p'_1 = 96$ $p'_2 = 214$	310	KE'_1 = 1536 KE'_2 = 4580 KE'_T = 6116

In case first and second no collision occurs because the velocities of the objects are same.

Table 3: For coefficient of restitution equal to 0.

Sr. No.	Mass (kg)	**Before Collision**				**After Collision**			
		Velocities (m/s)	Momentum (kg. m/s)	Net Momentum p = $p_1 + p_2$	Kinetic Energy (J)	Velocities (m/s)	Momentum (kg. m/s)	Net Momentum p = $p_1 + p_2$	Kinetic Energy (J)
1.	m_1=5 m_2=5	$v_1 = 45$ $v_2 = 45$	$p_1 = 225$ $p_2 = 225$	450	KE_1 =5062.5 KE_2 =5062.5 KE_T	v'_1 = -- v'_2 = --	p'_1 = -- p'_2 = --	--	KE'_1 = -- KE'_2 = -- KE'_T

PH160: Laboratory 2: Collision and Conservation of Momentum

					= 10125				= --
2.	m_1=1 m_2=4	$v_1 = 56$ $v_2 = 56$	$p_1 = 56$ $p_2 = 224$	280	KE_1 =1568 KE_2 =6272 KE_T = 7840	$v_1' =$ -- $v_2' =$ --	$p_1' =$ -- $p_2' =$ --	--	KE_1' = -- KE_2' = -- KE_T' = --
3.	m_1=1 m_2=1	$v_1 = 69$ $v_2 = 48$	$p_1 = 69$ $p_2 = 48$	117	KE_1 =2380.5 KE_2 = 1152 KE_T =3532.5	$v_1' = 59$ $v_2' = 59$	$p_1' = 59$ $p_2' = 59$	118	KE_1' =1711 KE_2' =1711 KE_T' =3481
4.	m_1=1 m_2=5	$v_1 = 82$ $v_2 = 46$	$p_1 = 82$ $p_2 = 230$	312	KE_1 = 3362 KE_2 = 5290 KE_T = 8652	$v_1' = 52$ $v_2' = 52$	$p_1' = 52$ $p_2' = 260$	312	KE_1' = 1352 KE_2' = 6760 KE_T' = 8112

In first two cases no collision will take place as the velocities of both the objects is equal.

Error-: There is an error in third entry of table 3 as the net final momentum is coming out to be greater than the net initial momentum. This is because the simulator is giving values without decimal places. The actual values (calculated) for table 3 are given in the table below (the errors are highlighted)

Sr. No.	Mass (kg)	Before Collision				After Collision			
		Velocities (m/s)	Momentum (kg. m/s)	Net Momentum p = $p_1 + p_2$	Kinetic Energy (J)	Velocities (m/s)	Momentum (kg. m/s)	Net Momentum p = $p_1 + p_2$	Kinetic Energy (J)

PH160: Laboratory 2: Collision and Conservation of Momentum

1.	m_1 =5 m_2 =5	$v_1 = 45$ $v_2 = 45$	$p_1 = 225$ $p_2 = 225$	450	KE_1 =5062.5 KE_2 =5062.5 KE_T = 10125	$v_1' = --$ $v_2' = --$	$p_1' = --$ $p_2' = --$	--	KE_1' = -- KE_2' = -- KE_T' = --
2.	m_1 =1 m_2 =4	$v_1 = 56$ $v_2 = 56$	$p_1 = 56$ $p_2 = 224$	280	KE_1 =1568 KE_2 =6272 KE_T = 7840	$v_1' = --$ $v_2' = --$	$p_1' = --$ $p_2' = --$	--	KE_1' = -- KE_2' = -- KE_T' = --
3.	m_1 =1 m_2 =1	$v_1 = 69$ $v_2 = 48$	$p_1 = 69$ $p_2 = 48$	117	KE_1 =2380.5 KE_2 = 1152 KE_T =3532.5	v_1' =58.5 v_2' =58.5	$p_1' = 58.5$ $p_2' = 58.5$	117	KE_1' =1711.12 KE_2' =1711.12 KE_T' =3422.25
4.	m_1 = 1 m_2 = 5	$v_1 = 82$ $v_2 = 46$	$p_1 = 82$ $p_2 = 230$	312	KE_1 = 3362 KE_2 = 5290 KE_T = 8652	$v_1' = 52$ $v_2' = 52$	$p_1' = 52$ $p_2' = 260$	312	KE_1' = 1352 KE_2' = 6760 KE_T' = 8112

Conclusion -: Performing the above experiment, we have come to following conclusions regarding different types of collisions

Elastic Collision -: a) v_1' and v_2' are given by,

$$v_1' = \frac{m_1 - m_2}{m_1 + m_2} v_1 + \frac{2m_2}{m_1 + m_2} v_2$$

$$v_2' = \frac{2m_1}{m_1 + m_2} v_1 + \frac{m_2 - m_1}{m_1 + m_2} v_2$$

b) If the mass of the objects is equal in an elastic head-on collision between two objects, the velocities of the objects interchange after the collision, i.e. The third entry in table 1 is our observation for the same.

$$v_1' = v_2 \text{ and } v_2' = v_1$$

c) The coefficient of restitution for an elastic collision is equal to 1.

Inelastic Collision -: a) v_1' and v_2' are given by,

$$v_1' = \frac{m_1 - em_2}{m_1 + m_2} v_1 + \frac{(1+e)m_2}{m_1 + m_2} v_2$$

$$v_2' = \frac{(1+e)m_1}{m_1 + m_2} v_1 + \frac{m_2 - em_1}{m_1 + m_2} v_2$$

b) It can be seen that the net momentum (in table 2 and table 3) is equal before and after the collision, but the total kinetic energy after the collision is less than the total kinetic energy before the collision. This implies that some energy is lost in an inelastic collision. The energy lost causes deformation in the objects during an inelastic collision.

c) The coefficient of restitution for an inelastic collision lies between 0 and 1.

d) A perfectly inelastic collision is one in which both the bodies stick together after the collision and move with same velocity (observed in table 3). Coefficient of restitution in a perfectly inelastic collision is 0.

PH160: Laboratory 2: Collision and Conservation of Momentum

Experiment 2: Collision Balls

Aim -: To verify the momentum and kinetic energy conservation using collision balls.

Theory -: The laws of conservations used in the experiment are:

1. Law of Conservation of Momentum -: It states that the total momentum of a system will remain conserved if there is no external force acting on the system.
2. Law of Conservation of Energy -: This law states that energy can neither be created nor be destroyed, it can only be transformed from one form to another.

Collision is the abrupt change in path of a body due to its interaction with another body (or bodies). As no external force acts on the system during collision, the net momentum of the system remains conserved. There are two types of collisions:

1. Elastic Collision -: The collision in which both the total momentum and the total kinetic energy remain conserved are elastic collisions. Coefficient of Restitution for such a collision is unity.
2. Inelastic Collision -: The collision in which the total momentum remains conserved but the total kinetic energy does not are inelastic collisions. The value of coefficient of restitution for inelastic collision is between zero and unity (including zero and excluding unity).

Formulae Used -: In collision in two dimensions, the velocity vector is broken into components along the x and y direction. Hence, the momentum vector also breaks up in two of its components.

Consider a collision of two balls of mass m_1 and m_2 in two dimensions. If the net external force acting on the system of the balls is zero, the net momentum of the system should remain conserved. As the collision is occurring in two dimensions, the momentum in each dimension will remain conserved.

Let $\overrightarrow{v_1} = v_{1x}\,\hat{\imath} + v_{1y}\hat{\jmath}$ be the initial velocity of ball m_1 and let initial velocity of ball m_2 be $\overrightarrow{v_2} = v_{2x}\,\hat{\imath} + v_{2y}\hat{\jmath}$. Therefore, the initial momentum of the system is,

$$\overrightarrow{p_i} = (m_1v_{1x} + m_2v_{2x})\hat{\imath} + (m_1v_{1y} + m_2v_{2y})\hat{\jmath}$$

Let the final velocities of the balls after the collision be $\overrightarrow{v_1'} = v_{1x}'\hat{\imath} + v_{1y}'\hat{\jmath}$ and $\overrightarrow{v_2'} = v_{2x}'\hat{\imath} + v_{2y}'\hat{\jmath}$.

$$\overrightarrow{p_f} = (m_1v_{1x}' + m_2v_{2x}')\hat{\imath} + (m_1v_{1y}' + m_2v_{2y}')\hat{\jmath}$$

From conservation of momentum,

$$\overrightarrow{p_i} = \overrightarrow{p_f}$$

$$(m_1v_{1x} + m_2v_{2x})\hat{\imath} + (m_1v_{1y} + m_2v_{2y})\hat{\jmath} = (m_1v_{1x}' + m_2v_{2x}')\hat{\imath} + (m_1v_{1y}' + m_2v_{2y}')\hat{\jmath}$$

PH160: Laboratory 2: Collision and Conservation of Momentum

Since total kinetic energy is conserved in elastic collision only, therefore the following equation can be used in case of elastic collision only,

$$\frac{1}{2}m_1v_1^2 + \frac{1}{2}m_2v_2^2 = \frac{1}{2}m_1v_1'^2 + \frac{1}{2}m_2v_2'^2$$

Observations -: Performing the experiment in the simulator gave following observations.

Table 1: For coefficient of restitution equal to 1

Sr. No.	Mass (kg)	Before Collision				After Collision			
		Velocities (m/s)	Momentum (kg. m/s)	Net Momentum p = $p_1 + p_2$	Kinetic Energy (J)	Velocities (m/s)	Momentum (kg. m/s)	Net Momentum p = $p_1 + p_2$	Total Kinetic Energy (J)
1.	m_1= 3 m_2= 3	$v_{1x} = 2$ $v_{1y} = 0$ $v_{2x} = 2$ $v_{2y} = 0$	$p_{1x} = 6$ $p_{1y} = 0$ $p_{2x} = 6$ $p_{2y} = 0$	p_x = 12 p_y = 0	KE_1 = 6 KE_2 = 6 KE_T = 12	$v_1' =$ 2.03 $v_2' =$ 1.999	$p_1' = 6.09$ $p_2' = 5.997$	12.08	KE_1' =6.195 KE_2' =5.999 KE_T' = 12.19
2.	m_1= 3 m_2= 4	$v_{1x} = 3$ $v_{1y} = 0$ $v_{2x} = 3$ $v_{2y} = 0$	$p_{1x} = 9$ $p_{1y} = 0$ $p_{2x} = 12$ $p_{2y} = 0$	p_x = 21 p_y = 0	KE_1 = 13.5 KE_2 = 18.0 KE_T = 31.5	$v_1' =$ 3.85 $v_2' =$ 2.15	$p_1' = 11.55$ $p_2' = 8.60$	20.15	KE_1' =22.30 KE_2' = 9.27 KE_T' =31.57
3.	m_1= 5 m_2= 5	$v_{1x} = 3$ $v_{1y} = 0$ $v_{2x} = 2$ $v_{2y} = 0$	$p_{1x} = 15$ $p_{1y} = 0$ $p_{2x} = 10$ $p_{2y} = 0$	p_x = 25 p_y = 0	KE_1 = 22.5 KE_2 = 10 KE_T = 32.5	$v_1' =$ 2.09 $v_2' =$ 2.90	$p_1' = 10.45$ $p_2' = 14.50$	24.95	KE_1' = 11.01 KE_2' = 21.50 KE_T' =32.51
4.	m_1= 3 m_2= 5	$v_{1x} = 3$ $v_{1y} = 0$ $v_{2x} = 1$ $v_{2y} = 0$	$p_{1x} = 9$ $p_{1y} = 0$ $p_{2x} = 5$ $p_{2y} = 0$	p_x = 14 p_y = 0	KE_1 = 13.5 KE_2 = 2.5 KE_T	$v_1' =$ 0.494 $v_2' =$ 2.493	$p_1' = 1.48$ $p_2' = 12.46$	13.94	KE_1' =0.36 KE_2' =15.53 KE_T'

PH160: Laboratory 2: Collision and Conservation of Momentum

					= 16				= 15.89

Table 2: For coefficient of restitution equal to 0.5

Sr. No.	Mass (kg)	Before Collision				After Collision			
		Velocities (m/s)	Momentum (kg. m/s)	Net Momentum p = $p_1 + p_2$	Kinetic Energy (J)	Velocities (m/s)	Momentum (kg. m/s)	Net Momentum p = $p_1 + p_2$	Total Kinetic Energy (J)
1.	m_1= 3 m_2= 3	$v_{1x} = 1$ $v_{1y} = 0$ $v_{2x} = 1$ $v_{2y} = 0$	$p_{1x} = 3$ $p_{1y} = 0$ $p_{2x} = 3$ $p_{2y} = 0$	p_x = 6 p_y = 0	KE_1 = 1.5 KE_2 = 1.5 KE_T = 3	$v_1' =$ 1.006 $v_2' =$ 0.515	$p_1' =$ 3.018 $p_2' =$ 1.545	4.563	KE_1' = 1.518 KE_2' = 0.398 KE_T' = 1.916
2.	m_1= 5 m_2= 1	$v_{1x} = 2$ $v_{1y} = 0$ $v_{2x} = 2$ $v_{2y} = 0$	$p_{1x} = 10$ $p_{1y} = 0$ $p_{2x} = 2$ $p_{2y} = 0$	p_x = 12 p_y = 0	KE_1 = 10 KE_2 = 2 KE_T = 12	$v_1' =$ 1.345 $v_2' =$ 3.487	p_1' = 6.725 p_2' = 3.487	10.212	KE_1' = 4.53 KE_2' = 6.08 KE_T' = 10.61
3.	m_1= 4 m_2= 4	$v_{1x} = 3$ $v_{1y} = 0$ $v_{2x} = 2$ $v_{2y} = 0$	$p_{1x} = 12$ $p_{1y} = 0$ $p_{2x} = 8$ $p_{2y} = 0$	p_x = 20 p_y = 0	KE_1 = 18 KE_2 = 8 KE_T = 26	$v_1' =$ 2.25 $v_2' =$ 2.54	p_1' = 9.00 p_2' = 10.16	19.16	KE_1' = 10.12 KE_2' = 15.05 KE_T' = 25.17
4.	m_1= 4 m_2= 2	$v_{1x} = 3$ $v_{1y} = 0$ $v_{2x} = 1$ $v_{2y} = 0$	$p_{1x} = 12$ $p_{1y} = 0$ $p_{2x} = 2$ $p_{2y} = 0$	p_x = 14 p_y = 0	KE_1 = 18 KE_2 = 4 KE_T	$v_1' =$ 2.008 $v_2' =$ 2.980	p_1' = 8.032 p_2' = 5.960	13.992	KE_1' = 8.06 KE_2' = 8.9 KE_T'

					= 22				= 16.96

Table 3: For coefficient of restitution equal to 0.1

Sr. No.	Mass (kg)	**Before Collision**				**After Collision**			
		Velocities (m/s)	Momentum (kg. m/s)	Net Momentum p = $p_1 + p_2$	Kinetic Energy (J)	Velocities (m/s)	Momentum (kg. m/s)	Net Momentum p = $p_1 + p_2$	Total Kinetic Energy (J)
1.	m_1= 2 m_2= 2	$v_{1x} = 1$ $v_{1y} = 0$ $v_{2x} = 1$ $v_{2y} = 0$	$p_{1x} = 2$ $p_{1y} = 0$ $p_{2x} = 2$ $p_{2y} = 0$	p_x = 4 p_y = 0	KE_1 = 1 KE_2 = 1 KE_T = 2	$v_1' =$ 1.00 $v_2' =$ 1.02	$p_1' = 2$ $p_2' = 2.04$	4.04	KE_1' = 1.012 KE_2' = 1.004 KE_T' = 2.016
2.	m_1= 2 m_2= 1	$v_{1x} = 2$ $v_{1y} = 0$ $v_{2x} = 2$ $v_{2y} = 0$	$p_{1x} = 4$ $p_{1y} = 0$ $p_{2x} = 2$ $p_{2y} = 0$	p_x = 6 p_y = 0	KE_1 = 4 KE_2 = 2 KE_T = 6	$v_1' =$ 2.00 $v_2' =$ 0.254	$p_1' = 4.00$ $p_2' = 0.254$	4.254	KE_1' = 4.024 KE_2' = 0.032 KE_T' = 4.056
3.	m_1= 3 m_2= 3	$v_{1x} = 4$ $v_{1y} = 0$ $v_{2x} = 2$ $v_{2y} = 0$	$p_{1x} = 12$ $p_{1y} = 0$ $p_{2x} = 6$ $p_{2y} = 0$	p_x = 20 p_y = 0	KE_1 = 24 KE_2 = 6 KE_T = 30	$v_1' =$ 3.02 $v_2' =$ 3.06	$p_1' = 9.06$ $p_2' = 9.18$	18.24	KE_1' = 13.66 KE_2' = 14.00 KE_T' = 27.66
4.	m_1= 5 m_2= 2	$v_{1x} = 4$ $v_{1y} = 0$ $v_{2x} = 1$	$p_{1x} = 20$ $p_{1y} = 0$ $p_{2x} = 2$	p_x = 22 p_y = 0	KE_1 = 40 KE_2 = 1	$v_1' =$ 3.06 $v_2' =$ 3.36	$p_1' = 15.3$ $p_2' = 6.72$	22.02	KE_1' = 23.40 KE_2' = 11.29

		$v_{2y}=0$	$p_{2y}=0$		KE_T = 41				KE'_T =34.69

Error-: If there is an infinite two-dimensional area and two balls have same velocity, they will never collide. But as in the simulator the two-dimensional area given is finite, collision is bound to occur.

- As for the first two entries of each table, the velocity of the balls is same, so one of the balls is bound to hit the wall before collision. Since in an elastic collision the kinetic energy remains conserved, the velocity of the ball after collision with the wall remains same and hence the first two entries in table 1 has been observed to be consistent with the conservation of momentum, and there is not much error. But in an inelastic collision, kinetic energy is lost due to deformation of balls, the input entries do not remain same after the ball being colliding with the wall and hence the first two entries in table 2 and 3 does not seem to be inconsistent with conservation of momentum, and contains significant error, but this is not the case.
- As for third and fourth entries in each table, the data is taken after the balls collided with each other such that no ball has hit the wall. This is possible because the balls have different velocities. This is why these entries has been observed to be consistent with the laws of conservation of energy and momentum for elastic and inelastic collisions, and the errors are not very significant.
- However, the final kinetic energy is supposed not to be greater than the initial kinetic energy. This error is observed in entries 1, 2 and 3 of table 1 and entry 1 of table 3. This error came into existence because the simulator was lacking control in putting up the velocities exactly. Hence, in some entries the velocity inputted was supposed to be 2 m/s but the actual value inputted is 2.006 m/s, which consequently increased the kinetic energy.
- This experiment was supposed to be performed for two-dimension collisions, but no entries in our observations has shown a two-dimension collision. This error is imposed because the simulator is not providing enough freedom to calculate the angles at which the balls are colliding, the velocities in the x and y direction before and after the collision. To make it easier only collisions in one dimension are considered.
- The last table has to be made using e = 0 , but the simulator was not allowing to go below 0.1.

Conclusion -: Performing this experiment in the simulator has taken us to following conclusions.

- The law of conservation of momentum is applicable in any type of collisions. Whether it is elastic or inelastic the net momentum of the system remains conserved.

- The law of conservation of energy is applicable only for the elastic collision but not for inelastic collision as a permanent deformation takes place in the colliding particles during an inelastic collision.