PHY1002 Physics Laboratory (2022-2023 Term 2)
Short Report

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Date of Experiment: March 6, 2023

Experiment 7. Conservation of Momentum

1. Calculate the initial and the final momentum of the system for the collisions below:

   (a) Completely Inelastic Collision for both equal mass carts and unequal mass carts.

      i. Initial momentum for inelastic collisions with equal mass is given by: $P = mv = 0.261 \pm 3.657 \times 10^{-5} \mathrm{kg}\frac{\mathrm{m}}{\mathrm{s}}$
      ii. Final momentum for inelastic collisions with equal mass is given by: $P = mv = 0.255 \pm 3.556 \times 10^{-5} \mathrm{kg}\frac{\mathrm{m}}{\mathrm{s}}$
      iii. Initial momentum for inelastic collisions with unequal mass is given by: $P = mv = 0.340 \pm 3.657 \times 10^{-5} \mathrm{kg}\frac{\mathrm{m}}{\mathrm{s}}$
      iv. Final momentum for inelastic collisions with equal mass is given by: $P = mv = 0.338 \pm 2.359 \times 10^{-5} \mathrm{kg}\frac{\mathrm{m}}{\mathrm{s}}$

   (b) Elastic Collisions for both equal mass carts and unequal mass carts.

      i. Initial momentum for elastic collisions with equal mass is given by: $P = mv = 0.307 \pm 4.288 \times 10^{-5} \mathrm{kg}\frac{\mathrm{m}}{\mathrm{s}}$
      ii. Final momentum for elastic collisions with equal mass is given by: $P = mv = 0.296 \pm 4.060 \times 10^{-5} \mathrm{kg}\frac{\mathrm{m}}{\mathrm{s}}$
      iii. Initial momentum for elastic collisions with unequal mass is given by: $P = mv = 0.404 \pm 5.652 \times 10^{-5} \mathrm{kg}\frac{\mathrm{m}}{\mathrm{s}}$
      iv. Final momentum for elastic collisions with equal mass is given by: $P = mv = 0.401 \pm 6.545 \times 10^{-5} \mathrm{kg}\frac{\mathrm{m}}{\mathrm{s}}$

2. Plot the graphs of total momentum (P_{total}) vs. time and total kinetic energy (KE_{total}) vs. time for all the cases mentioned in Question 1. (two graphs required: (a)P_{total} vs. time; and (b) KE_{total} vs. time for all the collisions)

   (a) Completely Inelastic Collision for both equal mass carts and unequal mass carts.

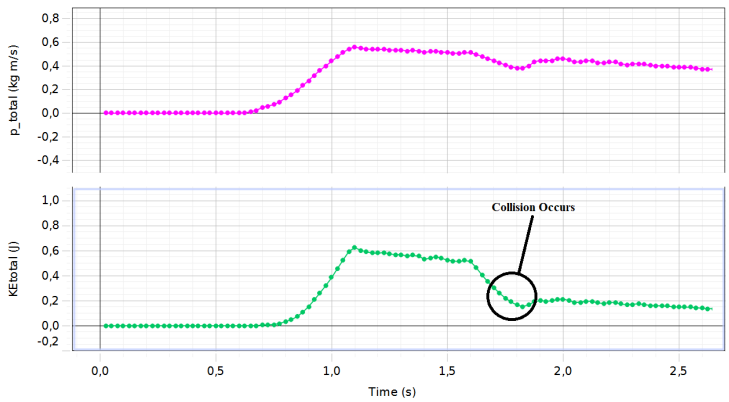

Figure 1: p-t and KE-t curve for inelastic collisions with equal mass

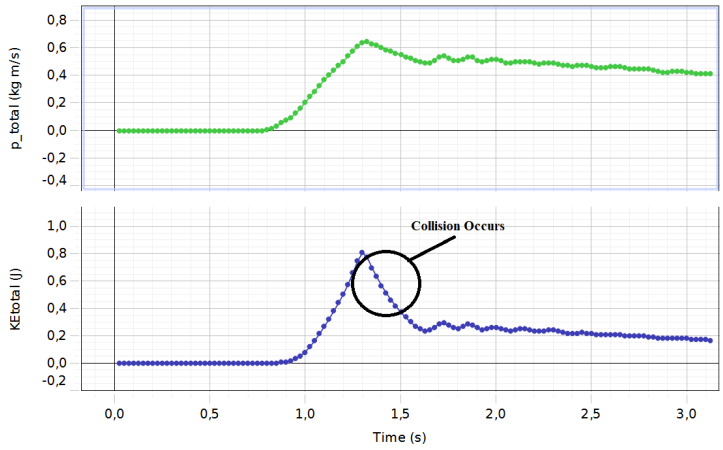

Figure 2: p-t and KE-t curve for inelastic collisions with unequal mass

(b) Elastic Collision for both equal mass carts and unequal mass carts.

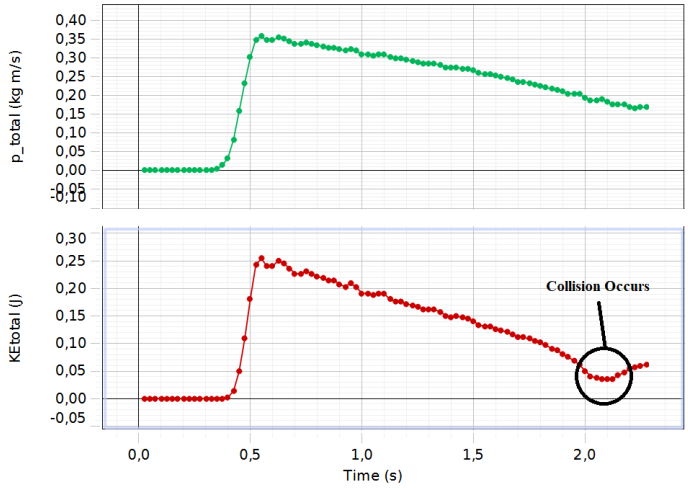

Figure 3: p-t and KE-t curve for elastic collisions with equal mass

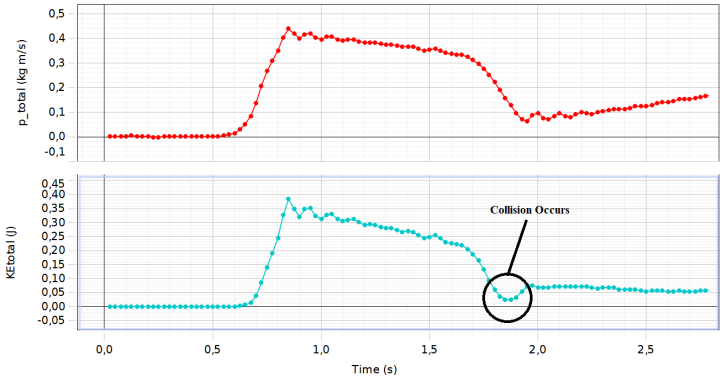

Figure 4: p-t and KE-t curve for elastic collisions with unequal mass

3. Explain the Graphs in Question 2. What happens before, during, and after the collisions in terms of momentum, velocity, and kinetic energy?

(a) Completely Inelastic Collision for both equal mass carts and unequal mass carts.

i. Equal mass carts
For the momentum vs. time graph, during the collision, the momentum is conserved the whole time, and both objects will stick together and move with the same velocity. All these are indicated by a sudden drop at the moment of collision and a straight line that follows the previous gradient before the sudden drop.
Since this is an inelastic collision, some kinetic energy will be lost during the collision as the objects deform and stick together. This is also indicated by a sudden drop at the moment of collision. The graph also shows that the kinetic energy after the collision stays constant, indicating that the kinetic energy is not conserved compared to the initial kinetic energy.

ii. Unequal mass carts
Similarly, during the collision, the momentum will still be conserved, but the larger object will experience less of a change in velocity than the smaller object since the smaller object is exerting a greater force on the larger object. This is also indicated by a sudden drop at the moment of collision and then a straight line that is horizontal after the collision.
Again, for the kinetic energy vs. time graph, some kinetic energy is lost during the collision. However, the larger object will experience less of a change in velocity than the smaller object, meaning that the larger object will have a greater kinetic energy after the collision than the smaller object. This means that the kinetic energy graph will show a sudden drop at the moment of collision and then a constant and lower kinetic energy after the collision.

(b) Elastic Collision for both equal mass carts and unequal mass carts.

i. Equal mass carts
Similar to the inelastic collision with equal mass carts, during the collision, momentum will still be conserved. However, in this case, kinetic energy will also be conserved, meaning that the momentum graph and the kinetic energy graph will show no change after the collision. The momentum graph will have a straight line that is horizontal after the collision.
Since this is an elastic collision, the kinetic energy will be conserved, and both objects will bounce off each other with the same velocity as before the collision. Exactly during the collision, the kinetic energy graph will show a sudden drop (only for a moment). These all are indicated through the kinetic energy graph that shows constant kinetic energy throughout the collision aside from a small sudden drop during the collision time.

ii. Unequal mass carts
With the same elastic environment, again, both momentum and kinetic energy will be conserved throughout the experiment. However, the smaller object will experience a larger change in velocity than the larger object, resulting in a decrease in kinetic energy. This means that the kinetic energy graph will show a sudden drop at the moment of collision and then a constant, lower kinetic energy after the collision, but the kinetic energy after the collision will be greater for the larger object than for the smaller object. This is shown in the graph.

Appendix

Attach the table in Procedure explosions, inelastic collisions, elastic collisions. (You should write a clear and detailed caption for each table.)

	Set	Set	Set	Set	Set
	Collision Type	Red Mass (kg)	Final Red v (m/s)	Blue Mass (kg)	Final Blue v (m/s)
1	Equal Mass Explosion	0,2714	-0,591	0,2710	0,561
2	Unequal Mass Explosion	0,2714	-0,718	0,7797	0,249

Set	Set	Set	Set	Set	Set	Set
Collision Type	Red Mass (kg)	Blue Mass (kg)	Init. Red v (m/s)	Init. Blue v (m/s)	Final Red v (m/s)	Final Blue v (m/s)
Equal Mass Inelastic	0,25023	0,25224	1,045	0,000	0,508	0,508
Unequal Mass Inelastic	0,25023	0,75224	1,360	0,000	0,337	0,337

Set	Set	Set	Set	Set	Set	Set
Collision Type	Red Mass (kg)	Blue Mass (kg)	Init. Red v (m/s)	Init. Blue v (m/s)	Final Red v (m/s)	Final Blue v (m/s)
Equal Mass Elastic	0,2714	0,2710	0,395	0	-0,012	0,388
Unequal Mass Elastic	0,2714	0,7797	0,407	0	-0,189	0,201

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