# Momentum

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6/18/2023

Activity 1: Elastic Collision with Equal Masses Data Table 1

**Table 1A. Cart A before collision.**

| **Cart A mass, m (kg)** | **Distance, d (m)** | **Time, t (s)** | **Average time, t (s)** | **Velocity = d/t (m/s) vA** |
| --- | --- | --- | --- | --- |
| *.0628kg* | *.30* | Trial 1: .13 | *.12* | *2.5 m/s* |
| Trial 2: .11 |
| Trial 3: .12 |

**Table 1B. Cart A after collision.**

| **Cart A mass, m (kg)** | **Distance, d (m)** | **Time, t (s)** | **Average time, t (s)** | **Velocity = d/t (m/s) vA’** |
| --- | --- | --- | --- | --- |
| *.0628kg* | *.1* | Trial 1: .51 | *.53* | *0.19* |
| Trial 2: .55 |
| Trial 3: .52 |

**Table 1C. Cart B after collision.**

| **Cart B mass, m (kg)** | **Distance, d (m)** | **Time, t (s)** | **Average time, t (s)** | **Velocity = d/t (m/s) vB’** |
| --- | --- | --- | --- | --- |
| *.0628kg* | *.30* | Trial 1: .21 | *.23* | *1.3* |
| Trial 2: .23 |
| Trial 3: .24 |

**Calculations for Activity 1. Elastic Collision with Equal Masses**

Apply the law of conservation of momentum to the two-cart system by calculating the momentum before and after the collision.

Helpful equations:

Momentum before the collision = 𝑚𝐴𝒗𝐴 + 𝑚𝐵𝒗𝐵

Momentum after the collision = 𝑚𝐴𝒗𝐴′ + 𝑚𝐵𝒗𝐵′

𝑚𝐴𝒗𝐴 + 𝑚𝐵𝒗𝐵 = 𝑚𝐴𝒗𝐴′ + 𝑚𝐵𝒗𝐵′

1. Calculate the momentum of the system before the collision (the left side of the equation) and after the collision (the right side of the equation).
2. 0.0628 (2.5) + 0.0628(0) = 0.0628(0.19) + 0.0628(1.3)
3. 0.157 = 0.2

1. Calculate the percent difference between the two values.
2. 31.4%
3. Explain any difference in the values before and after the collision.
4. Some of the kinetic energy was converted into sound on impact with some extra being lost to friction and air resistance.

Activity 2: Elastic Collision: Mass Added to Cart A Data Table 2

**Table 2A. Cart A before collision.**

| **Cart A mass, m (kg)** | **Distance, d (m)** | **Time, t (s)** | **Average time, t (s)** | **Velocity = d/t (m/s) vA** |
| --- | --- | --- | --- | --- |
| *0.1424kg* | *.30m* | Trial 1: 0.11 | *0.12s* | *2.5 m/s* |
| Trial 2: 0.12 |
| Trial 3: 0.13 |

**Table 2B. Cart A after collision.**

| **Cart A mass, m (kg)** | **Distance, d (m)** | **Time, t (s)** | **Average time, t (s)** | **Velocity = d/t (m/s) vA’** |
| --- | --- | --- | --- | --- |
| *0.1424kg* | *.30m* | Trial 1: 0.42 | *0.42s* | *0.71 m/s* |
| Trial 2: 0.42 |
| Trial 3: 0.43 |

**Table 2C**. **Cart B after collision.**

| **Cart B mass, m (kg)** | **Distance, d (m)** | **Time, t (s)** | **Average time, t (s)** | **Velocity = d/t (m/s) vB’** |
| --- | --- | --- | --- | --- |
| *.0628kg* | *.30m* | Trial 1: 0.13 | *0.14s* | *2.14m/s* |
| Trial 2: 0.15 |
| Trial 3: 0.14 |

**Calculations for Activity 2. Elastic Collision: Mass Added to Cart A**.

Apply the law of conservation of momentum to the two-cart system by calculating the momentum before and after the collision.

Helpful equations:

Momentum before the collision = 𝑚𝐴𝒗𝐴 + 𝑚𝐵𝒗𝐵

Momentum after the collision = 𝑚𝐴𝒗𝐴′ + 𝑚𝐵𝒗𝐵′

𝑚𝐴𝒗𝐴 + 𝑚𝐵𝒗𝐵 = 𝑚𝐴𝒗𝐴′ + 𝑚𝐵𝒗𝐵′

1. Calculate the momentum of the system before the collision (the left side of the equation) and after the collision (the right side of the equation).

0.1424(2.5) +0.0628(0) = 0.1424(0.7) + 0.0628(2.14)

0.356 = 0.234072

0.121928 / 0.590072

1. Calculate the percent difference between the two values.

9.5%

1. Explain any difference in the values before and after the collision.

Some of the kinetic energy was converted into sound on impact with some extra being lost to friction and air resistance. That being said it is very similar so it was likely much easier to move the kinetic energy onto the second cart since it had nothing in it.

Activity 3: Elastic Collision: Mass Added to Cart B Data Table 3

**Table 3A. Cart A before collision.**

| **Cart A mass, m (kg)** | **Distance, d (m)** | **Time, t (s)** | **Average time, t (s)** | **Velocity = d/t (m/s) vA** |
| --- | --- | --- | --- | --- |
| *0.1424* | *.30* | Trial 1: .12 | *.12s* | *2.5 m/s* |
| Trial 2: .11 |
| Trial 3: .13 |

**Table 3B. Cart A after collision.**

| **Cart A mass, m (kg)** | **Distance, d (m)** | **Time, t (s)** | **Average time, t (s)** | **Velocity = d/t (m/s) vA’** |
| --- | --- | --- | --- | --- |
| *0.1424* | *.30* | Trial 1: 0.43 | *.43s* | *0.7 m/s* |
| Trial 2: 0.45 |
| Trial 3: 0.42 |

**Table 3C. Cart B after collision.**

| Cart B mass, m (kg) | Distance, d (m) | Time, t (s) | Average time, t (s) | Velocity = d/t (m/s) vB’ |
| --- | --- | --- | --- | --- |
| *0.1424* | *.30* | Trial 1: 0.25 | *.25s* | *1.2 m/s* |
| Trial 2: 0.27 |
| Trial 3: 0.24 |

**Calculations for Activity 3. Elastic Collision: Mass Added to Cart B**.

Apply the law of conservation of momentum to the two-cart system by calculating the momentum before and after the collision.

Helpful equations:

Momentum before the collision = 𝑚𝐴𝒗𝐴 + 𝑚𝐵𝒗𝐵

Momentum after the collision = 𝑚𝐴𝒗𝐴′ + 𝑚𝐵𝒗𝐵′

𝑚𝐴𝒗𝐴 + 𝑚𝐵𝒗𝐵 = 𝑚𝐴𝒗𝐴′ + 𝑚𝐵𝒗𝐵′

1. Calculate the momentum of the system before the collision (the left side of the equation) and after the collision (the right side of the equation).
2. 0.1424(2.5) + 0.1424(0) = 0.1424(0.7) + 0.1424(1.2)
3. 0.356 = .27056
4. .08544 0.62656
5. Calculate the percent difference between the two values.

15.79%

1. Explain any difference in the values before and after the collision.

*The difference wasn’t too major here I think it could still be attributed to being changed into friction, sound energy and air resistance.*

**Questions for Momentum**:

1. The law of conservation of momentum states that the total momentum before a collision equals the total momentum after a collision provided there are no outside forces acting on the objects in the system. What outside forces are acting on the present system that could affect the results of the experiments?
2. Air resistance, friction from the ground and the surface that I was conducting the experiment on, wood flooring may have played a part.
3. What did you observe when Cart A containing added mass collided with Cart B containing no mass? How does the law of conservation of momentum explain this collision?

Cart A continued after hitting cart B when it had nothing in it with cart B in front of it. Cart B seemed to have absorbed the force from cart A and was being forced a long with it.

1. In one of the experiments, Cart A may reverse direction after the collision. How is this accounted for in your calculations?

*I subtracted the movement backwards from cart A’s velocity to account for the reverse movement.*