# Momentum

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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** |
| --- | --- | --- | --- | --- |
| *0.069kg* | *0.50m* | Trial 1: 0.64s | *0.71s* | *0.70* |
| Trial 2: 0.72s |
| Trial 3: 0.78s |

**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’** |
| --- | --- | --- | --- | --- |
| *0.069kg* | *0.50m* | Trial 1: 0.92s | *0.70s* | *0.71* |
| Trial 2: 0.53s |
| Trial 3: 0.67s |

**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’** |
| --- | --- | --- | --- | --- |
| *0.072kg* | *0.50m* | Trial 1: 0.53s | *0.63s* | *0.79* |
| Trial 2: 0.62s |
| Trial 3: 0.73s |

**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).

𝑚𝐴𝒗𝐴 + 𝑚𝐵𝒗𝐵

(0.069kg)(0.70) + (0.072kg)(0)

=0.05 kg\*

𝑚𝐴𝒗𝐴′ + 𝑚𝐵𝒗𝐵′

(0.069kg)(0.71) + (0.072kg)(0.79)

’=0.11 kg\*

1. Calculate the percent difference between the two values.

*=18.75%*

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

The main difference in values was massed on the fact that after the collision cart b had a momentum of 0.79 (causing the second value to be 0.11) while before the cart was stationary (causing the first value to be 0.05).

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** |
| --- | --- | --- | --- | --- |
| *2.094kg* | *0.50m* | Trial 1: 0.61s | *0.68s* | *0.74* |
| Trial 2: 0.72s |
| Trial 3: 0.70s |

**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’** |
| --- | --- | --- | --- | --- |
| *2.094kg* | *0.50m* | Trial 1: 1.67s | *1.61s* | *0.31* |
| Trial 2: 1.60s |
| Trial 3: 1.56s |

**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’** |
| --- | --- | --- | --- | --- |
| *0.071kg* | *0.50m* | Trial 1: 0.50s | *0.51s* | *0.98* |
| Trial 2: 0.47s |
| Trial 3: 0.55s |

**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).

𝑚𝐴𝒗𝐴 + 𝑚𝐵𝒗𝐵

(2.094kg)(0.74) + (0.071kg)(0)

=1.55 kg\*

𝑚𝐴𝒗𝐴′ + 𝑚𝐵𝒗𝐵′

(2.094kg)(0.31) + (0.071kg)(0.98)

’=.72 kg\*

1. Calculate the percent difference between the two values.

*=18.28%*

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

In this activity the main reasons for the difference in values are one the fact that before collision cart ‘b’ is stationary and how the mass of cart ‘a’ has now been increased by the washers.

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** |
| --- | --- | --- | --- | --- |
| *0.974kg* | *0.35m* | Trial 1: 0.46s | *0.48s* | *0.73* |
| Trial 2: 0.52s |
| Trial 3: 0.46s |

**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’** |
| --- | --- | --- | --- | --- |
| *0.974g* | *0.35m* | Trial 1: 0.23s | *0.20s* | *-1.75* |
| Trial 2: 0.18s |
| Trial 3: 0.18s |

**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’** |
| --- | --- | --- | --- | --- |
| *3.856kg* | *0.35m* | Trial 1: 1.26s | *1.03s* | *0.33* |
| Trial 2: 1.05s |
| Trial 3: 0.78s |

**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).

𝑚𝐴𝒗𝐴 + 𝑚𝐵𝒗𝐵

(0.974kg)(0.73) + (3.856kg)(0)

= 0.71 kg\*

𝑚𝐴𝒗𝐴′ + 𝑚𝐵𝒗𝐵′

(0.974kg)(-1.75) + (3.856 kg)(0.33)

’= -0.43 kg\*

1. Calculate the percent difference between the two values.

*=203.57%*

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

The difference in the values is all caused by 2 products in the activity. The first being that cart ‘b’ is stationary before the collision but not after the collision. The second being that in this activity cart ‘b’ has a significantly higher mass than cart ‘a’ causing the cart ‘a’ to have a negative velocity after collision.

**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?

Airflow could play a major role in acting as an outside force. Another example I had personally was pet hair kept flying on to my ramp causing a slight amount of fiction to the equation.

1. 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?

When Cart A containing added mass collided with Cart B we noticed that momentum caused Cart B to then move in the same directional path that cart A was on at nearly a bit higher velocity. But the system’s total momentum remained the same.

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

In activity 3 we see Cart A reverse direction. We can also see this within the calculations because the velocity of Cart A after collision is then negative.