

Collisions

A group of physics students are investigating the effect of the mass of two colliding carts upon their post-collision velocities. Being vectors, the velocities can be positive (for moving rightward) or negative (for moving leftward).

Experiment 1

In Experiment 1, the students place Cart B at rest on the track. They push Cart A towards it. The two carts are equipped with Velcro strips so that they stick together when they collide. The two carts collide and move together at the same speed after the collision. They use a motion detector to determine the velocity of Cart A before and after the collision. They conduct several trials while varying the mass of the two carts by adding bricks to them. Their data is shown in **Table 1**.

Table 1

Trial	Mass of A (kg)	Mass of B (kg)	Pre-Collision Velocity of A (cm/s)	Post-Collision Velocity of A (cm/s)
1	0.50	0.50	34	17
2	0.50	1.00	42	14
3	0.50	1.50	36	9
4	0.50	2.00	40	8
5	1.00	0.50	33	22
6	1.50	0.50	36	27
7	1.00	1.00	36	18

Experiment 2

In Experiment 2, the students arrange the carts so that magnets embedded in their ends repel each other before contact is made. Once again, they place Cart B at rest on the track and push Cart A towards it. After *the collision*, the carts move along the track at separate velocities. Their velocities are measured using motion detectors. Several trials are conducted using different mass combinations. Their data is shown in **Table 2**.

Table 2

Trial	Mass of A (kg)	Mass of B (kg)	Pre-Collision Velocity of A (cm/s)	Post-Collision Velocity of A (cm/s)	Post-Collision Velocity of B (cm/s)
8	0.50	0.50	32	0	32
9	0.50	1.00	36	-12	24
10	0.50	1.50	42	-21	21
11	0.50	2.00	38	-23	15
12	1.00	0.50	33	11	44
13	1.50	0.50	32	16	48
14	1.00	1.00	40	0	40

Questions

1. What is a dependent variable in these two experiments?
 - a. The mass of Cart A only.
 - b. The pre-collision velocity of Cart A.
 - c. The mass of both Cart A and B.
 - d. The post-collision velocity of Cart A.
2. Which one of the following statements is an accurate criticism of the design of this experiment?
 - a. The students performed too many trials; big ideas can get lost in so many little details.
 - b. The students should have performed at least a few trials with Cart B moving before the collision.
 - c. The students failed to control the pre-collision velocity of Cart A; this variable would affect the post-collision velocity.
 - d. The students should have calculated something; its senseless to make measurements without actually calculating something from them.
3. Which of the following statements describe the effect of increasing mass of Cart A upon the post-collision velocity as observed in **Experiment 1**?
 - a. The mass of Cart B increases.
 - b. The pre-collision velocity of cart A increases.
 - c. The post-collision velocity of cart A increases.
 - d. The post-collision velocity of cart B decreases.
4. In **Experiment 1**, if the ratio of masses of Cart A to Cart B is 1:4, how do the pre- and post-collision velocities compare?
 - a. The post-collision velocity is four times greater than the pre-collision velocity.
 - b. The post-collision velocity is one- fourth the value of the pre-collision velocity.
 - c. The post-collision velocity is five times greater than the pre-collision velocity.
 - d. The post-collision velocity is one-fifth the value of the pre-collision velocity.
5. Which one of the following statements is consistent with all the results reported in **Table 1**?
 - a. Cart B is always moving slower after the collision than it is before the collision.
 - b. Cart A is always moving slower after the collision than it is before the collision.
 - c. The velocity of Cart B after the collision is always one-half of Cart B's velocity before the collision.
 - d. When the masses of the two carts are equal, the post-collision velocity equals the pre-collision velocity.
6. Using **Table 1**, identify the statement that most fully describes the post-collision velocity that results from equal-mass cart collisions.
 - a. The two carts travel with a velocity that is twice that of Cart A's pre-collision velocity.
 - b. The two carts travel with a velocity that is one-half that of Cart A's pre-collision velocity.
 - c. Cart A stops moving and Cart B moves with the same velocity that Cart A originally had.
 - d. The two carts travel with a velocity that is slower than the velocity they had before the collision.

7. What would be post-collision velocity of two carts that *stick together* if their masses are 1.0-kg and Cart A collides with stationary Cart B while moving 36 cm/s?
- 0 cm/s
 - 18 cm/s
 - 36 cm/s
 - 72 cm/s
8. What would be post-collision velocity of two carts that *stick together* if their masses are 1.0-kg and Cart A collides with stationary Cart B while moving 22 cm/s?
- 0 cm/s
 - 11 cm/s
 - 22 cm/s
 - 44 cm/s
9. A 2.0-kg cart moving at 60 cm/s approaches a 1.0-kg cart that is initially at rest. The two carts magnetically repel each other before actual contact is made. Which trial would provide sufficient evidence for predicting the post-collision speed of the two carts?
- Trial 2
 - Trial 5
 - Trial 9
 - Trial 12
10. A 3.0-kg cart moving at 60 cm/s approaches a 1.0-kg cart that is initially at rest. The two carts magnetically repel each other before actual contact is made. What is the post-collision velocity of the two carts?
- Cart A: 40 cm/s; Cart B: 20 cm/s
 - Cart A: 20 cm/s; Cart B: 40 cm/s
 - Cart A: -20 cm/s; Cart B: 20 cm/s
 - Cart A: 30 cm/s; Cart B: 90 cm/s
11. The collisions in **Table 2** are often referred to as perfectly elastic collisions. What mathematical equation accurately relates the pre- and post-collision velocities (v) of carts A and B for all the perfectly elastic collisions? NOTE: the ' symbol indicates *after the collision*.
- $v_A = v_B'$
 - $v_A * v_A' = v_B'$
 - $v_A + v_B' = v_B + v_A'$
 - $v_A + v_A' = v_B + v_B'$
12. What conditions in **Table 2** would be required for Cart A to reverse directions and move backwards after the collision?
- The faster that Cart A moves, the more likely it will do this.
 - The slower that Cart A moves, the more likely it will do this.
 - Cart A reverses its direction if it is less massive than Cart B.
 - Cart A reverses its direction if it is more massive than Cart B.
13. Based on **Table 2**, which of the following conditions would result in the fastest post-collision velocity for Cart B?
- Cart A moves fast before the collision and is the less massive of the two objects.
 - Cart A moves slowly before the collision and is the less massive of the two objects.
 - Cart A moves fast before the collision and is many times more massive than Cart B.
 - Cart A moves slowly before the collision and is many times more massive than Cart B.