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 the purpose of these two experiments?
   a. To study general principles regarding collisions.
   b. To measure the post-collision velocity of the two carts.
   c. To determine the effect of cart mass upon the post-collision velocities.
   d. To investigate collisions in order to determine if the velocity is conserved.

2. Which of the following statements describe the effect of increasing the mass of Cart B as observed in **Experiment 1**?
   a. The mass of Cart A 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 A decreases.

3. 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?
   a. Trial 2 b. Trial 5
   c. Trial 9 d. Trial 12

4. 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?
   a. Cart A: 40 cm/s; Cart B: 20 cm/s b. Cart A: 20 cm/s; Cart B: 40 cm/s
   c. Cart A: -20 cm/s; Cart B: 20 cm/s d. Cart A: 30 cm/s; Cart B: 90 cm/s

5. 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*.
   a. $v_A = v_B'$ b. $v_A * v_A' = v_B'$
   c. $v_A + v_B' = v_B + v_A'$ d. $v_A + v_A' = v_B + v_B'$

6. Based on **Table 2**, which of the following conditions would result in the fastest post-collision velocity for Cart B?
   a. Cart A moves fast before the collision and is the less massive of the two objects.
   b. Cart A moves slowly before the collision and is the less massive of the two objects.
   c. Cart A moves fast before the collision and is many times more massive than Cart B.
   d. Cart A moves slowly before the collision and is many times more massive than Cart B.