Main Topic	Forces & Newton's Laws	Description: Qualitatively investigate elastic collisions and "explosions" using Human Dynamics Carts.
Subtopic	Momentum	
Learning Level	Middle	
Technology Level	Low	
Activity Type	Student	

Required Equipment	2 Human Dynamics Carts, 1 sandbag or other weight, meter stick or measuring tape
Optional Equipment	Motion Sensor

Educational Objectives

- Qualitatively describe the law of conservation of momentum after observing different types of collisions.

Concept Overview

Students will observe "explosions," in which one student on a dynamics cart pushes another. From this, they will confirm the relationship between mass and velocity in determining momentum. They will also reinforce the idea of a closed system by experimenting with which student provides the pushing force.

Then a single student on a cart will participate in inelastic and elastic collisions with a thrown weight. Students will observe that a faster throwing speed results in a faster cart speed for both collision types. They will also observe that more force is imparted to the objects in elastic collisions, and make conclusions about technological design based on that observation.

Lab Tips

Students should wear safety helmets during this experiment, and always sit firmly on the cart with a low center of gravity.

Weighted balls ("medicine balls") borrowed from the gym are excellent for this experiment.

Life-Size Collisions

Name: ____________________

Class: _____________________

Goal:

Observe and describe different types of collisions.

Materials:

2 Human Dynamics Carts, 1 sandbag or other weight, meter stick or measuring tape

Procedure:

I. "Explosions"

1. Choose two people of similar size and seat one on each cart. Arrange the carts so they can roll directly away from each other.
2. Have one person sit as solidly as possible on their cart while the other person "stiff-arms" them in the back, pushing them away.
3. Describe the speeds of the two carts as they move apart. Fill in the blank with *equals*, *is greater than*, or *is less than*. (It may be difficult to judge the speed. Instead, look at the distances the carts travel before stopping, and make conclusions about their initial speeds.)

   For equal mass, the speed of Cart 1 _______________ the speed of Cart 2.

4. Reverse the roles, having the person who pushed before do the pushing this time. How does this affect the result?

5. Now use two people of very different mass, or give one person a heavy weight to hold in their lap. Repeat the experiment.

   For unequal mass, the speed of the heavier cart _______________ the speed of the lighter cart.

6. An object's momentum depends on its ________________ and its _________________. If the momentum is the same, increasing the mass _____________________(increases/decreases) the velocity.

II. Collisions

7. Position one person on one cart. Gently (but <u>horizontally</u>) toss the weight to them so that it can be caught. Observe the distance the cart travels.
8. Repeat the experiment, throwing the weight faster this time. Complete the data table below, using the following terms: *small positive*, *small negative*, *large positive*, *large negative*.

Object 1 (the weight) speed	Collision type	Object 2 (the cart) speed
Small positive	Inelastic	
Large positive	Inelastic	

9. Repeat the experiment, this time creating an elastic collision. Give the person on the cart a basketball or other large elastic object with which to rebound the weight. Throw the weight with similar speeds to before, and make comparisons to the resulting cart speeds.

Object 1 (the weight) speed	Collision type	Object 1 (weight) speed after collision	Object 2 (the cart) speed after collision
Small positive	Elastic		
Large positive	Elastic		

10. In which type of collision, elastic or inelastic, did the cart rider feel the greatest <u>force</u>?

11. Engineers design highway barriers using materials like flexible metal and barrels of water, so that they will collapse in the event of a collision. Explain the reasoning behind this design. Be sure to describe the type of collision involved with hitting one of these barriers versus something like a concrete wall.