Name: _____ Date: _____

Different Momentum Cases

You can use either of these equations to solve for unknown values in the different collision cases.

Conservation of momentum relationships

$$\underbrace{m_A \times \Delta v_A}_{\text{Change in momentum of object A}} + \underbrace{m_B \times \Delta v_B}_{\text{Change in momentum of object A}} = 0$$

$$\underbrace{m_A \times v_{Af} + m_B \times v_{Bf}}_{\text{Total final momentum}} = \underbrace{m_A \times v_{Ai} + m_B \times v_{Bi}}_{\text{Total initial momentum}}$$

final momentum of object A — final momentum of object B

initial momentum of object A — Initial momentum of object B

This the result of:

- An unbalanced net force, acting on each object , causing a change in its motion.
- The two forces are in the system equal in magnitude and opposite in direction to each other at every point in time there is an interaction.

When the forces from other interactions are much smaller in magnitude than the average collision force, bounding the system around objects A and B still provides a close approximation of the outcomes.

Question 1: On windy days or on icy surfaces, unattended shopping carts in parking lots can end up rolling into other vehicles or other carts. A shopping cart corral is a structure that was designed to help prevent such collisions.

The data in the table to the right describe the outcome of a collision in which one cart filled with groceries (A) rolled into an empty cart (B).

Shopping cart	Mass	Velocity before the collision	Velocity after the collision
A	90 kg	+0.50 m/s	0.25 m/s
B		0 m/s	0.75 m/s

1a) Draw and label the system. Include the parts interacting in this system, their related variables, and the boundary of the system.

1b) What does our mathematical model predict the mass of the empty cart B must be? Show how you solved for this unknown using one of our momentum equations.

1c) Why does your use of this equation provide a reasonable approximation of the outcomes for the system you defined?

Question 2: On windy days or on icy surfaces, unattended shopping carts in parking lots can end up rolling into other vehicles or other carts. A shopping cart corral is a structure that was designed to help prevent such collisions.

These data describe the outcome of a collision between two grocery carts, one with some groceries in it (C) and one with less in it (D).

Shopping cart	Mass	Velocity before the collision	Velocity after the collision
C	50 kg	+0.50 m/s	-0.30 m/s
D	40 kg	-0.40 m/s	

2a) Draw and label the system. Include the parts interacting in this system, their related variables, and the boundary of the system.

2b) What does our mathematical model predict the final velocity of cart D would be? Show how you solved for this unknown using one of our momentum equations.

2c) Why does your use of this equation provide a reasonable approximation of the outcomes for the system you defined?

Question 3: Switcher engines are used to move train cars from one track to another in train yards, to prepare a long chain of train cars for transport out of the train yard by a larger engine. To save time and fuel in shuffling cars around, railyard workers sometimes uncouple a car the engine has been pushing, so it coasts along the track until it collides with the chain of stationary cars that it needs to be connected to.

- The single tanker car is rolling at a nearly constant speed when it collides with and couples to 9 other tanker cars.
- All of these cars end up moving together at 0.1 m/s as a result of this collision, in the same direction that the single tanker car was initially moving.
- Every tanker car has a mass of 119,000 kg.

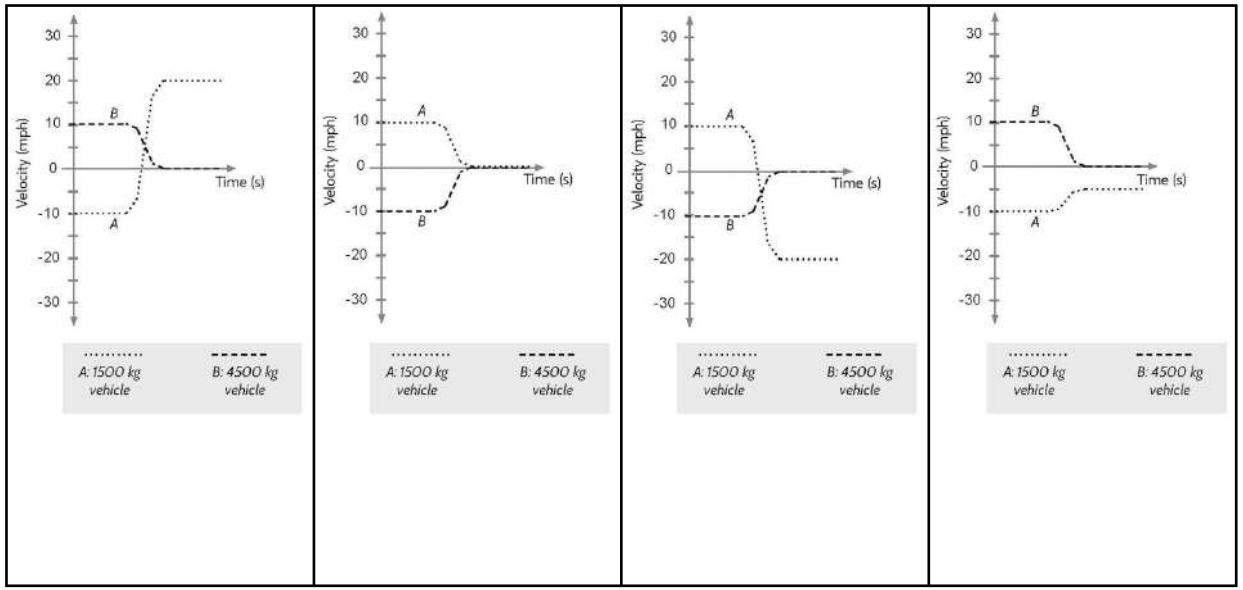
3a) Draw and label the system. Include the parts interacting in this system, their related variables, and the boundary of the system.

3b) How fast must the tanker car have been moving before such a collision?

3c) Is this collision elastic or inelastic? How do you know?

Question 4: A head-on collision occurs between two vehicles. The smaller vehicle (A) is 1,500 kg and is moving at 10 mph before the collision. The larger vehicle (B) is 4,500 kg and is moving at 10 mph in the opposite direction before the collision. The larger vehicle comes to a stop as a result of the contact forces in the collision. **For each graph, indicate whether it shows the expected velocity change in the smaller vehicle (write yes or no for each, and explain why).**

4a) Draw and label the system. Include the parts interacting in this system, their related variables, and the boundary of the system.



4b)	4c)	4d)	4e)