Name _____

Momentum is conserved if $F_{ext} = 0$: Conservation of Momentum: $p_{0A} + p_{0B} = p_{fA} + p_{fB}$

Elastic Collisions: Kinetic Energy is also conserved

Inelastic Collisions: Momentum is conserved, but KE is not

Perfectly (Completely Inelastic) Collisions: 2 Objects stick together

Super Elastic Collisions (Explosions): KE is gained

1. Consider the ball being hit by a baseball in the previous handout. It was hit with a force of 6600N and the initial speed was 33.5m/s and we found the final speed to be about 57.5m/s. Would it require more or less force to attain the final speed of 57.5m/s if it is instead hit from rest, from a batting tee? Calculate how much force is required.

2. Make a prediction. We have two balls, a bouncy one and a non-bouncy "dead" ball with the same mass. If both of them hit a block of wood with the same speed, which one will make the block fall over? Discuss with your neighbor.

3. In the following situations, indicate whether the collision is **elastic, inelastic**, **completely inelastic**, or **super elastic**.

   (a) A bullet is shot into a stationary block of wood. The block moves a short distance on a flat surface with the bullet stuck inside. What type of collision is this? Is momentum conserved during the collision?

   Is the momentum of the bullet/block combination conserved after the collision?

   (b) Two identical hockey pucks, both moving towards each other collide and rebound off each other with no loss in speed. What type of collision is this? Is momentum conserved?

   (c) A car crashes into a tree. What type of collision is this? Is momentum conserved?

   (d) An object at rest explodes into two equal mass pieces that move in opposite directions at the same speed. What type of collision is this? Is momentum conserved?

   (e) Two cars sliding on frictionless ice crash into each other head on and come to a stop. What type of collision is this? Is momentum conserved?

(f) Two siblings play bumper cars. The kid sister (m=20kg) sneaks up on her brother (m=20kg) from behind going 8m/s, while her brother is moving at a slow speed of 2m/s. After they collide, the brother moves faster (6m/s) in the same direction, while the sister is still moving in the same direction but at a slower speed (4m/s) than her brother. What type of collision is this? Check if momentum is conserved.

(g) A ball is dropped from a height of 1m above the ground, bounces, and returns to the same height of 1m above the ground. What type of collision does the ball have with the ground?

Is momentum conserved?

4. Make a prediction. If we drop a basketball with a tennis ball resting on top, what will happen to the two balls after they hit the ground? Discuss with your neighbor.

5. Say a cart with a mass of $2kg$ is moving at a speed of $0.3m/s$. If I drop my water bottle, with a mass of $5kg$ on top, what will be the final speed of the cart plus water bottle? What type of collision is this?

6. A truck with mass $3000kg$ moving at $30m/s$ crashes head on with a car with mass $1500kg$ on an icy road (no friction) and they both stop. What was the speed of the car before they collided? What type of collision was this?

7. You are the crash scene investigator for the Grand Junction police and are tasked with investigating an incident in which a small Volkswagen ($900kg$) crashed into a stationary Toyota 4-runner truck ($1500kg$) at a traffic light. The skid marks on the ground are 5m long and you know $\mu_k = 0.75$ between tire rubber and pavement. You need to determine whether the Volkswagen was speeding before it crashed into the Toyota. Criminal charges can be filed in Colorado if your speed exceeds $30mi/hr$ over the speed limit. The speed limit in the area where the crash occurred was $40mi/hr$. Can you arrest the driver? (Hint: 1m/s = 2.24mi/hr)