Physics 200 Name: _____
Momentum & Impulse: wrap-up and review

Review Questions and Problems:

1. State the Law of Conservation of Momentum. **When there are no external forces acting on a system, the total amount of momentum in a system remains constant.**
For example, the sum of the momentums of two objects before they collide is equal to the sum of those objects' momentums after they collide.

2. When does the Law of Conservation of Momentum apply? When does it not apply?
Momentum is conserved when there are no external forces acting on a system. It does not apply when there is an external force.

3. The law of conservation of momentum applies to *closed* systems. With regard to momentum, what is a closed system?
With regard to momentum, a "closed system" is not affected by an outside (external) force.

4. When is Mechanical Energy conserved? When is it not conserved?
Mechanical energy is conserved when there are no external forces and when a system is frictionless. It is not conserved whenever friction acts within a system or when there is an outside force acting on the system.

5. Define impulse and tell how the impulse experienced by an object relates to that object's momentum.
Impulse is a force exerted for a period of time. As a quantity, impulse equals force multiplied by time. An impulse acting on an object causes an equal change in the object's momentum. Impulse can be positive or negative, causing a positive or negative change in an object's momentum.

6. Many protective devices reduce the impact force during collisions. Some examples include ski helmets, airbags, pools of water, and haystacks. Use the concepts of impulse and momentum to explain how these devices stop a moving object without damaging the object. **In order for a moving object to be brought to a stop, it must lose all of its velocity, and therefore it must lose its momentum. This change in the object's momentum is brought about by an impulse equal to that change in momentum. Impulse equals impact force multiplied by impact time. When an impact is cushioned (by haystack, ski helmet, airbag, or pool of water), the moving object comes to a stop more slowly. In other words, the impact time is lengthened. Impulse =Ft, so, for a given impulse, a longer impact time requires a smaller impact force.**

7. Explain the difference between an elastic collision and an inelastic collision.
In an elastic collision, both momentum and kinetic energy are conserved.
In an inelastic collision, momentum is conserved, but kinetic energy is lost to friction.

8. Two objects collide with perfect **elasticity**. What does that tell us about their velocities before and after the collision? **The separation speed of the two objects after the collision is equal to the closing speed of the two objects after the collision. Another way to say this is that the absolute values of their differences in speed are the same before and after the collision.**

9. Two objects collide with perfect **inelasticity**. What does that tell us about their velocities before and after the collision? **After the collision, the objects have the same velocity. Before the collision, their velocities are different.**

10. Why does the law of conservation of momentum apply to all collisions, whether they are elastic or inelastic? **In every collision, the colliding objects exert force against one another. Newton's 3rd law says that these forces are equal and opposite. Since the impact time is the same for each object, the impulse (Ft) exerted on each object is equal and opposite (same time, opposite force). Impulse is equal to change in momentum, so if each object experiences an opposite impulse, it also experiences an opposite change in momentum. Therefore, the momentum gained by one object is offset by the equal loss of momentum by the other object. Just as forces are equal and opposite in a collision, changes in momentum are also equal and opposite. There is no *net* change in momentum.**

11. Provide a quick description of each of the equations (top three rows) in the box on the right. Paraphrase what each equation is telling us.
The first equation is the law of conservation of momentum. The total momentum before some event is equal to the total momentum after the event.

Impulse = impulse force x impact time = change in momentum
change in momentum = mass x change in velocity.

$$\textbf{Coefficient of Restitution} = \frac{separation\ speed}{closing\ speed}$$

Good Stuff

$p_A + p_B = p_A' + p_B'$

$F\Delta t = \Delta p = m\Delta v$

$e = (v_B' - v_A')/(v_A - v_B)$

e = 1 means perfectly elastic
e = 0 means perfectly inelastic