Physics 200 (Stapleton)
Momentum Notes and Ballistic Pendulums

Name: ______________________

Notes - 8.3 Conservation of Momentum

1. Write the conservation of momentum principle for 2 objects in an isolated (closed) system.

$\Delta p_{Net} = 0 \quad p_i = p_f$

$m_{1i} v_{1i} + m_{2i} v_{2i} = m_{1f} v_{1f} + m_{2f} v_{2f}$

2. An isolated system is defined to be one in which the net external force = 0.

3. Note that from $F_{net} = \Delta p/\Delta t$, when $F_{net} = 0$ then Δp_{Tot} = 0 (i.e. the total momentum is constant).

Notes - 8.4 & 8.5 Elastic and Inelastic Collisions

1. All collisions conserve momentum. An **elastic** collision is one that also conserves KE.

2. How is an inelastic collision different from an elastic collision?

Does not conserve KE ⇒ $\Delta KE \neq 0$

3. When a collision is **inelastic** (not elastic), where does the "lost" kinetic energy go?

Potential Energy, Heat, Sound, light

4. Give some examples of nearly elastic collisions between macroscopic objects.

- Newton's Cradle
- Billiard Balls
- Springy cart hitting force sensor

<u>**Ballistic Pendulums**</u>

Formulas: $KE = \frac{1}{2}mv^2$ $p = mv$ $PE = mg\square$ $m_i v_i = m_i v_i$

Impulse = Ft = Δp

Consider the system below, which includes a ballistic pendulum (box) and a projectile (circle). Assuming that the string supports of the pendulum have negligible friction, and assuming that air resistance is also negligible...

Does not change

...when is momentum conserved? Why?

Between #1 + #2. No net external force acting on them.

...when is momentum not conserved? ~~Why~~ How can we tell?

#2 → #3. ~~[crossed out]~~ → In #3, v=0, so p=0. In #2, v≠0, so p≠0

...when is KE conserved? Why?

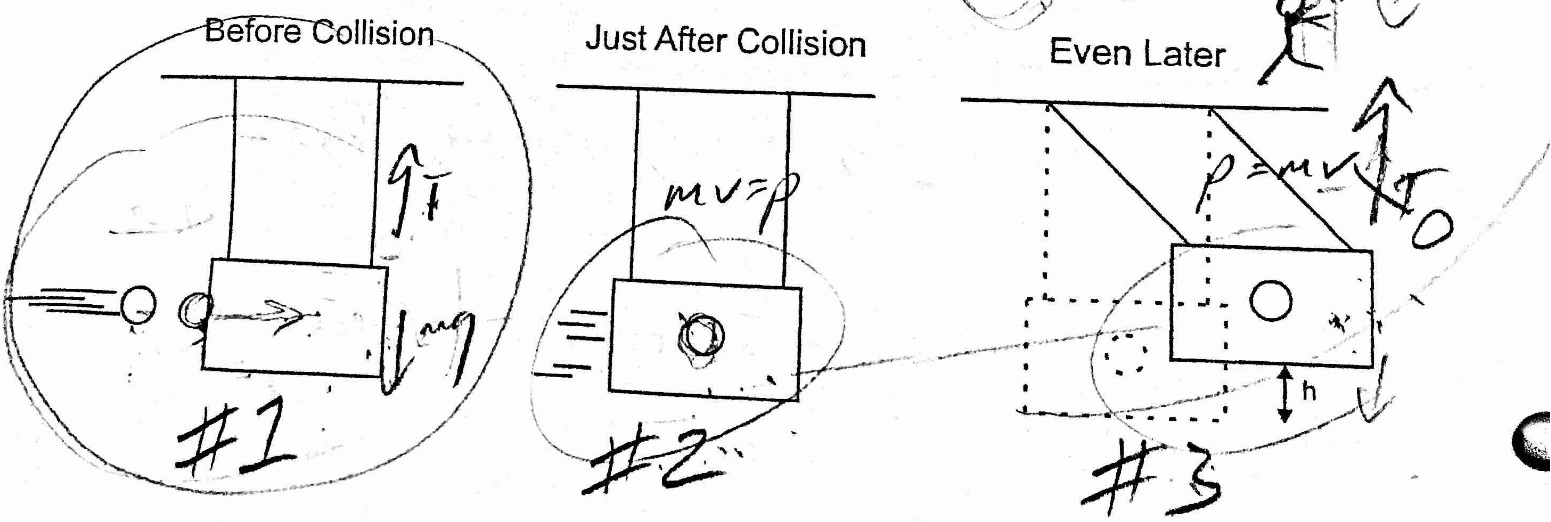
Never

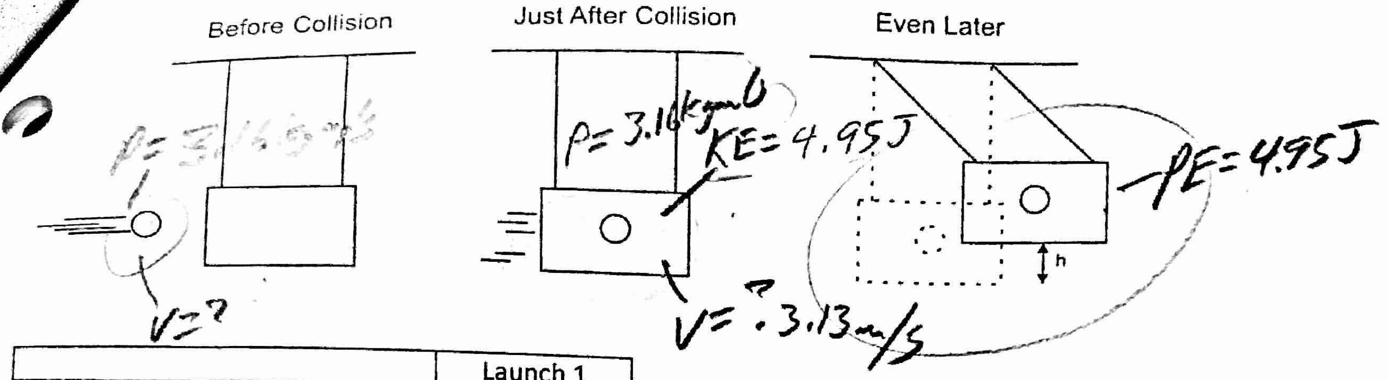
...when is KE not conserved? Why?

#1 → #2, because there is friction when the projectile embeds.

#2 → 3, KE turns to PE

$W_{Net} = \Delta KE$





	Launch 1
Projectile Mass (kg)	0.01
Pendulum Mass (kg)	1
Swing Height, "h" (m)	0.5

Answer the following questions using "launch 1" data. Complete the rest on your own.

1. What is the total potential energy of the ball and pendulum in the "even later" picture?

$PE = mgh = 1.01\,kg\,(9.8\,m/s^2)(0.5\,m) = 4.95\,J$

2. What was the total kinetic energy of the ball and pendulum in the "just after" picture?

$4.95\,J$

3. What was the shared velocity of the ball and pendulum in the "just after" picture?

$KE = \frac{1}{2}mv^2 \Rightarrow v = \sqrt{\frac{2KE}{m}} = \sqrt{\frac{2(4.95\,J)}{1.01\,kg}} = 3.13\,m/s$

4. What was the net momentum of the ball and pendulum in the "just after" picture?

$p = mv = (1.01\,kg)(3.13\,m/s) = 3.16\,kg\,m/s$

5. What was the momentum of the ball before the collision?

$3.16\,kg\,m/s$

6. What was the velocity of the ball before the collision?

$p = mv \quad v = \frac{p}{m} = \frac{3.16\,kg\,m/s}{0.01\,kg} = 316\,m/s$

7. Prove that this was an inelastic collision.

$KE_i = \frac{1}{2}mv^2 = \frac{1}{2}(0.01\,kg)(316\,m/s)^2 = 499\,J$

Ball