Physics 105 Workshop Problems #9: Collisions

Collision Type	Momentum Conserved	Energy Conserved
Elastic	Yes $m_1v_{1i}+m_2v_{2i}=m_1v_{1f}+m_2v_{2f}$	Yes $v_{1i}+v_{1f}=v_{2i}+v_{2f}$
Inelastic	Yes $m_1v_{1i}+m_2v_{2i}=m_1v_{1f}+m_2v_{2f}$	No $\varepsilon=\dfrac{v_{2f}-v_{1f}}{v_{1i}-v_{2i}}$
Perfectly Inelastic	Yes $m_1v_{1i}+m_2v_{2i}=(m_1+m_2)v_f$ $(m_1+m_2)v_i=m_1v_{1f}+m_2v_{2f}$	No

A perfectly inelastic event can:

- start with objects together (raft & man, hockey player & puck, etc.) and end with them apart
- start with objects apart (two or more blocks, two or more cars, etc.) and end with them melding together

ALTERNATE KE/M FORMULA (Elastic collisions only)

$$v_1+V_1=V_2+v_2$$

COEFFICIENT OF RESTITUTION

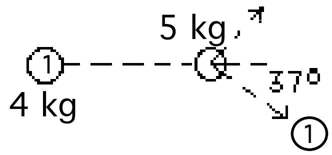
$$\varepsilon=\frac{V_2-V_1}{v_1-v_2}$$

1. A block at rest is hit by another block coming in at 5 m/s. After the collision they stick together and move at 3 m/s. What is the ratio of their masses? [$m_1 = 3/2m_2$] masses

2. Two blocks of mass 5 and 4 kg are involved in an elastic collision. The 5 kg ball is at rest and the other hits it head on going at 2 m/s. What are their velocities after the collision? [$V_1 = 16/9$ m/s, $V_2 = -2/9$ m/s] What would be their velocities if both balls were 5 kg each? [$V_1 = 0$, $V_2 = 2$ m/s]

3. Two blocks, separated by a distance of 2 meters, are moving in the same direction at 5 m/s. The first one with a mass of 5 kg, hits a third block of mass 10 kg initially at rest; it bounces back and hits the second block of mass 3 kg. What are the final velocities of the blocks if all the collisions are elastic? [**After the first collision:** block C moves at 10/3 m/s, block B bounces

back at -5/3 m/s and hits block two; **after the second collision:** m_A bounces back at -10/3 m/s and block B bounces back (in the positive direction) at 10/3 m/s (yes, the absolute values of the velocities of A & B are the same after the second collision)]



4. A 4 kg ball traveling at 2 m/s, hits a 5 kg ball, initially at rest, and bounces off at 37° from its initial direction, going at 1 m/s. What is the velocity of the other ball after the collision? [V_2 = 1.07 m/s; θ = 27°, Q1] Is the collision elastic? [no, $KE_0 \neq KE_f$]

5. A man on a motionless raft jumps from the raft with a speed of 3 ft/sec with respect to the raft. If the man weighs 150 lb and the raft 400 lb, what are their final velocities with respect to the water? [Vm = 2.18ft/s; Vr = -0.82ft/s]

6. In the preceding problem, let's say there are two 150-lb men on the raft, and they both jump with a speed of 3 ft/s with respect to the raft. Will the final velocity of the raft be greater if the two jump together or if they jump one after the other? [both jump together: V_{men} = 12/7 ft/s, V_{raft} = -9/7 ft/s; greater if the men jump individually)

7. Two blocks of 2 and 3 kg mass are moving toward each other at the speeds of 6 and 10m/s respectively. They hit with a coefficient of restitution of 0.4. What are their final velocities? [V_1 = -7.44 m/s, V_2 = -1.04 m/s]

8. What is ε in a collision if kinetic energy is conserved? [ε = 1]