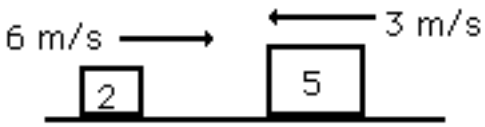
HW#8: MOMENTUM



1. Two blocks of masses 2 kg and 5 kg are moving towards each other, at speeds of 6 and 3 m/s respectively, and collide.
a. What will be their velocities if the collision is perfectly elastic? [V_1 = -48/7 m/s, V_2 = +15/7 m/s]
b. If the first block was to bounce backward with a speed of 4 m/s, what would be the coefficient of restitution of the collision? *(Note: This collision is NOT perfectly elastic!)* [ε = 0.556]
c. How much energy was lost in the collision? [40.0 J]

2. A 100 kg hockey player is skating down the ice at 10 m/s pushing a 1.5 kg puck. He shoots the puck forward at 50 m/s with respect to himself. What are the velocities of each after the shot? [Vpuck = 59.26 m/s]

3. At the scene of an automobile accident a physics pathologist studies the wreckage. She determined that the first car (mass = 2000 kg) was traveling east, and a sport car (mass = 1200 kg) was traveling north. There were no skid marks before the collision, but the masses of the two were stuck together afterwards. Analyzing further, it was determined that the mass after the collision was proceeding at 30 km/hr at 50° North of East.

a) How fast were the two cars going before impact in kph? [v_1 = 30.8 km/hr, v_2 = 61.2 km/hr]
b) How much energy was lost due to impact? [1.359 x 10^5 J]

4. A bullet with a mass of 4.0 g and a speed of 650 m/s is fired a a block of wood with a mass of 0.095 kg. The block rests on a frictionless surface, and is thin enough that the bullet passes completely through it. Immediately after the bullet exits the block, the speed of the block is 23 m/s.

a. What is the speed of the bullet when it exits the the block. [V_1 = 103.8 m/s]
b. Is the final Kinetic energy of this system equal to, less than, or greater than the initial KE? Why? [energy was not conserved]
c. Verify the answer to "b" by calculating the initial and final kinetic energies of the system [Beginning: KE bullet is 845J, after impact the block's KE= 25.13J, the bullet's KE = 21.53J]
d. After the bullet exits the block, the block continues to slide of a flat surface where μ_k = 0.54. What distance did the block slide from the point where the bullet exited the block to its final resting place? [50 m]

5. A 3000 kg cannon is mounted so that it can recoil only in the horizontal direction.

a. Calculate its recoil velocity when it fires a 15.0 kg shell at 480 m/s at an angle of 20° above the horizontal. [2.26 m/s backwards]
b. What is the kinetic energy of the cannon? This energy is dissipated as heat transfer in the shock absorbers that stop its recoil. [7.63 x 10^3 J]
c. What happens to the vertical component of momentum that is imparted to the cannon when it is fired?

6. **Explanation**: In a nuclear reactor, neutrons released by nuclear fission must be slowed down before they can trigger additional reactions in other nuclei.
Question: To see what sort of material is most effective in slowing/containing a neutron (m= 1.009u where 1u = 1.66 x 10^{-27}kg) calculate the ratio of a neutron's final KE to its initial KE (KE_f/KE_o), assuming that the neutrons involved are traveling at 7% the speed of light for a head on elastic collision with each of the following stationary target particles,

a. an electron, (m=5.49 x10^{-4}u) [$V_f = 2.098 \times 10^6$ m/s]
b. a proton (m=1.007u) [$V_f = 20.83 \times 10^4$ m/s; $KE_f/KE_i = 9.84 \times 10^{-7}$]
c. a water molecule (m=18u) [$V_f = -1.877 \times 10^6$ m/s; bounces backwards]
d. a lead atom (m=207.2u): [$V_f = -2.08 \times 10^6$ m/s; bounces backwards]

7. Two freight trucks collide and their wreckage is melded together, but 1/3 of the total mass is thrown from the wreckage. One truck had a working GPS and from its data it is known that

a. one truck (m_1 = 100,000 kg including cargo) was traveling at 90 kph at 22.0° north of east.
b. the wreckage right after the collision moving at 3.6 kph at 67.0° north of west

if the total mass of the two trucks and cargo before impact was 216,000 kg, what was the velocity in kph of the second truck?
[v_2 = 77.8 kph; 18.7° North of West]