Homework No. 07 (Fall 2021)

PHYS 203A: COLLEGE PHYSICS

Department of Physics, Southern Illinois University–Carbondale
Due date: Tuesday, 2021 Oct 26, 12.30pm, on D2L

Instructions

- Describe your thought process in detail and organize it clearly. Make sure your answer has the correct units and the right number of significant digits.

- After completion, scan the pages as a single PDF file, and submit the file on D2L (Assesments → Assignments).

1. (**10 points.**) A drop of rain and a pellet of hail, of same masses $m = 1.00\,\text{g}$, hits the roof of a car with same speed $v = 5.00\,\text{m/s}$. Rain drop being liquid stays in contact with the roof for $100.0\,\text{ms}$, while hail being solid rebounds (assume with same speed $v = 5.00\,\text{m/s}$) and thus stays in contact for a mere $1.00\,\text{ms}$. Calculate the force exerted by each on the roof of the car.

2. (**10 points.**) A ball having a mass of $150\,\text{g}$ strikes a wall with a speed of $5.0\,\text{m/s}$ and rebounds with only $50\,\%$ of its initial kinetic energy.

   (a) What is the speed of the ball immediately after rebounding?

   (b) If the ball was in contact with the wall for for $8.0\,\text{ms}$, what was the magnitude of the average force on the ball from the wall during this time interval?

3. (**10 points.**) A shooter of mass $90.0\,\text{kg}$ shoots a bullet of mass $3.00\,\text{g}$ in a direction $60.0°$ with respect to the horizontal, standing on a frictionless surface at rest. If the muzzle velocity of the bullet is $600.0\,\text{m/s}$, what is the recoil speed of the shooter?

4. (**10 points.**) A car of mass $m_1 = 2000.0\,\text{kg}$ is moving at speed $v_{1i} = 35.0\,\text{m/s}$ towards East. A truck of mass $m_2 = 5000.0\,\text{kg}$ is moving at speed $v_{2i} = 25.0\,\text{m/s}$ towards South. They collide at an intersection and get entangled (complete inelastic collision). What is the magnitude and direction of the final velocity of the entangled automobiles?

5. (**10 points.**) Two masses, $m_1 = 1.0\,\text{kg}$ and $m_2 = 2.0\,\text{kg}$ are hanging off separate strings. Forst mass m_1 is pulled to a height $h_1 = 1.0\,\text{m}$ and dropped. It swings down and collides with the other hanging mass (m_2 at rest) and they stick to each other (complete inelastic collision). See Figure 1. The collision happens in a plane. How high do the masses rise together after the collision.
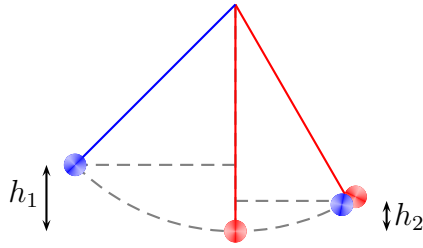
Figure 1: Problem 5.

6. (**10 points.**) What is the ratio of the final kinetic energy to initial kinetic energy in a perfectly inelastic collision involving two particles of masses m and M when the mass M is initially at rest? Express your answer in terms of m and M.

7. (**10 points.**) A mass $m_1 = 100.\,\text{kg}$ moving with a speed $v_{1i} = +10.\,\text{m/s}$ (elastically) collides with another mass $m_2 = 1.0\,\text{kg}$ initially at rest. Determine the magnitude and direction of the final velocities of the masses after collision.