AP Physics C
Review Chapter 7 Momentum

1. A golfer strikes a golf ball of mass 0.05 kg, and the time of impact between the golf club and the ball is 1 ms. If the ball acquires a velocity of 70 m/s, calculate the average force exerted on the ball.

2. A football team's kicker punts the ball (mass = 0.42 kg) and give it a launch speed of 30 m/s. Find the impulse delivered to the football by the kicker's foot and the average force exerted by the kicker on the ball, given that the impact time is 8 ms.

3. An 80 kg stuntman jumps out of a window that's 50 m above the ground.
   a. How fast is he falling when he reaches the ground level?

   b. He lands on a large, air-filled target, coming to rest in 1.5 s. What average force does he feel while coming to rest?

   c. What is he had instead landed on the ground with an impact time of 10 ms?

4. An astronaut is floating in space near her shuttle when she realizes that the cord that's supposed to attach her to the ship has become disconnected. Her total mass is 90 kg. She reaches into her handy-dandy astronaut pocket, finds a 1 kg metal tool, and throws it out into space with a velocity of 6 m/s directly away from the ship. If the ship is 10 m away, how long will it take her to reach it?

5. Two balls roll toward each other. The red ball has a mass of 0.5 kg and a speed of 4 m/s just before impact. The green ball has a mass of 0.3 kg and a speed of 2 m/s. If the collision is completely inelastic, determine the velocity of the "redgreen" ball after the collision.

6. An object of mass m_1 is moving with velocity v_1 toward a target object of mass m_2 which is stationary. The objects collide head-on, and the collision is elastic. Show that the relative velocity before the collision, $v_2 - v_1$, has the same magnitude as $v_2' - v_1'$, the relative velocity after the collision.

7. An object of mass m moves with velocity v towards a stationary object $2m$. After impact, the objects move off in the directions shown.
   a. Determine the magnitudes of the velocities after the collision (in terms of v)

   b. Is the collision elastic? Justify your answer.

Before the collision

After the collision
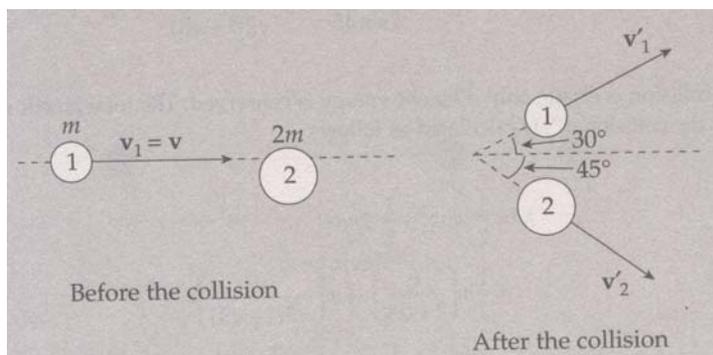
8. Two objects, one of mass m and one of mass 2m, hang from light threads from the ends of a uniform bar of length 3L and mass 3m. The masses m and 2m are at distances L and 2L, respectively, below the bar. Find the center of mass of this system.
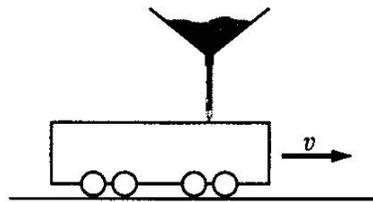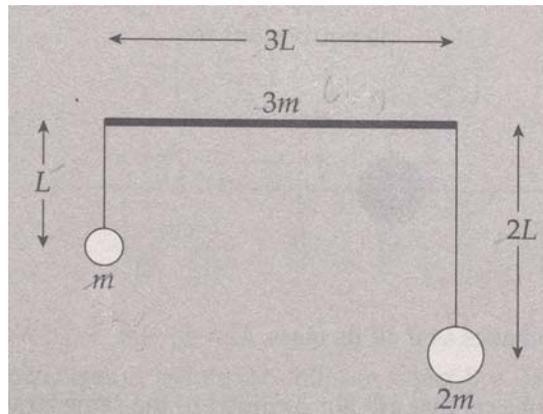
9. An open-top railroad car (initially empty and of mass M_0) rolls with negligible friction along a straight horizontal track and passes under the spout of a sand conveyor. When the car is under the conveyor, sand is dispensed from the conveyor in a narrow stream at a steady rate $\Delta M/\Delta t = C$ and falls vertically from an average height h above the floor of the railroad car. The car has initial speed v_0 and sand is filling it from time $t = 0$ to $t = T$. Express your answers to the following in terms of the given quantities and g.

(a) Determine the mass M of the car plus the sand that it catches as a function of time t for $0 < t < T$.

(b) Determine the speed v of the car as a function of time t for $0 < t < T$.

(c) i. Determine the initial kinetic energy K_i of the empty car.

   ii. Determine the final kinetic energy K_f of the car and its load.

   iii. Is kinetic energy conserved? Explain why or why not.

(d) Determine expressions for the normal force exerted on the car by the tracks at the following times.

   i. Before $t = 0$

   ii. For $0 < t < T$

   iii. After $t = T$