Homework Assignment 4

Due: Monday, June 13, 2016

Problem 1: A lion of mass 150 kg and a grizzly bear of mass 300 kg are charging directly towards each other at 75 km/h and 40 km/h respectively. Find the magnitude of momentum of

(a) the lion.

(b) the bear.

(c) the lion-bear system.

Problem 2: A tennis ball of mass 60 g hits a wall horizotally at a speed of 30 m/s and rebounds with the same speed. Just before and just after collision, the ball is traveling horizontally.

(a) What is the magnitude of momentum of the ball just before collision? What is the magnitude of momentum of the ball just after collision?

(b) What is the magnitude of the change in momentum of the ball?

(c) If the collision between the wall and the ball lasts for 0.1 s, what is the magnitude of average force during collision?

Problem 3: A person of mass 70 kg is standing on an icy (frictionless) horizontal surface with a metal ball of mass 5 kg. The person throws the ball at a speed of 2 m/s, at an angle of 60° above the horizontal. Both speed and angle are as measured *with respect to the ground*.

(a) What is the recoil speed with which the person slides after throwing the ball?

(b) What is velocity of the ball as seen by the person? Give the magnitude and direction (angle above horizontal).

Problem 4: Same problem, slightly different math. A person of mass 70 kg is standing on an icy (frictionless) horizontal surface with a metal ball of mass 5 kg. The person throws the ball at a speed of 2 m/s, at an angle of 60° above the horizontal. Both speed and angle are as measured *with respect to the person*. What is the velocity of the ball with respect to the ground? Give the magnitude and direction (angle above horizontal).

Problem 5: Particles A, B and C of masses 5 g, 10 g and 15 g respectively are located at coordinates (5 m, 7 m), (3 m, 4 m), (-6 m, 2m) respectively [cartesian (x, y) coordinates]. Find the coordinates of the center of mass.

Problem 6: A two object system is known to have its center of mass moving at 3 m/s in the +x-direction. The two components have masses M and $M/2$. The heavier component is moving at 4 m/s at an angle of 60° above the +x-axis. Find the velocity (magnitude and direction) of the lighter compenent.

Problem 7: On a pool table, the cue ball, traveling at a speed of v, hits an object ball at rest head on (one dimensional collision). The cue ball and the object ball have the same mass. After collision, the cue ball keeps moving forward at a third of its original speed. What is the speed of the object ball after collision?

Problem 8: A car is traveling down a road at 50 m/s when Captain America latches onto it from the side of the road. If Captain America's mass is 100 kg, and the speed of the car immediately after he gets on it is 45 m/s, what is the mass of the car (without including Captain America)? Assume that Cap was at rest on the ground before latching on.

Problem 9: On a pool table, the cue ball traveling at speed of 2 m/s in the +x-direction hits an object ball at rest. The cue ball and the object ball have the same mass. After collision, the x-component of the cue ball's velocity is 0.5 m/s, and the y-component of the object ball's velocity is $\frac{\sqrt{3}}{2}$ m/s. Find the velocities of the cue ball and object ball (magnitude and direction). What is the angle between the velocity vectors of the cue ball and object ball after collision?

Problem 10: Two objects A and B collide. Just before collision the two objects are moving only in the x-direction (either +x or -x direction). Just after collision, object A keeps moving in the x-direction (either +x or -x direction). Can object B have a non-zero compenent of velocity along the y-direction just after collision? If yes, give an example. If no, explain why not.