Problem Set 9  
Due: see website for due date

Chapter 11: Rolling, Torque, and Angular Momentum  
Exercises & Problems: 7, 14, 60, 63, 65

Problem A  
Explain how a child “pumps” on a swing to make it go higher.

Problem B  
While driving his motorcycle at highway speeds, a physics student notices that pulling back lightly on the right handlebar tips the cycle to the left and produces a left turn. Explain why this happens.

Problem C  
I’ve noticed that when I apply the front brakes on my bike it stops quite quickly. If I apply the back brakes only while going the same speed, it skids rather than stopping quickly. Why?

Problem D  
When you rev the engine of your car with the transmission in neutral, you notice that the car rocks in the opposite sense of the engine’s rotation. Explain this in terms of conservation of angular momentum. Is the angular momentum of the car conserved for long, that is, for more than a few seconds?

Problem 11.7  
A solid cylinder of radius 10 cm and mass 12 kg starts from rest and rolls without slipping a distance $L = 6.0$ m down a roof that is inclined at the angle $\theta = 30^\circ$. (a) What is the angular speed of the cylinder about its center as it leaves the roof? (b) The roof’s edge is at height $H = 5.0$ m. How far horizontally from the roof’s edge does the cylinder hit the level ground?

Problem 11.14  
A small, solid, uniform ball is to be shot from point P so that it rolls smoothly along a horizontal path, up along a ramp, and onto a plateau. Then it leaves the plateau horizontally to land on a game board, at a horizontal distance $d$ from the right edge of the plateau. The vertical heights are $h_1 = 5.00$ cm and $h_2 = 1.60$ cm. With what speed must the ball be shot at point P for it to land at $d = 6.00$ cm?
Problem 11.60
A 1.0 g bullet is fired into a 0.50 kg block attached to the end of a 0.60 m nonuniform rod of mass 0.50 kg. The block–rod–bullet system then rotates in the plane of the figure, about a fixed axis at A. The rotational inertia of the rod alone about that axis at A is 0.060 kg·m². Treat the block as a particle. (a) What then is the rotational inertia of the block–rod–bullet system about point A? (b) If the angular speed of the system about A just after impact is 4.5 rad/s, what is the bullet’s speed just before impact?

Problem 11.63
A 30 kg child stands on the edge of a stationary merry-go-round of mass 100 kg and radius 2.0 m. The rotational inertia of the merry-go-round about its rotation axis is 150 kg·m². The child catches a ball of mass 1.0 kg thrown by a friend. Just before the ball is caught, it has a horizontal velocity v of magnitude 12 m/s, at angle $\phi = 37^\circ$ with a line tangent to the outer edge of the merry-go-round, as shown. What is the angular speed of the merry-go-round just after the ball is caught?

Problem 11.65
Two 2.00 kg balls are attached to the ends of a thin rod of length 50.0 cm and negligible mass. The rod is free to rotate in a vertical plane without friction about a horizontal axis through its center. With the rod initially horizontal, a 50.0 g wad of wet putty drops onto one of the balls, hitting it with a speed of 3.00 m/s and then sticking to it. (a) What is the angular speed of the system just after the putty wad hits? (b) What is the ratio of the kinetic energy of the system after the collision to that of the putty wad just before? (c) Through what angle will the system rotate before it momentarily stops?