# Physics 21 Problem Set 5

Harry Nelson

**due Tuesday, Feb. 8 at 5pm**

**Course Announcements: Midterm, Monday, Feb. 7**. Material through Problem Set 4. Bring a bluebook, a caculator, pencil, and one page of notes.

Reading for these Problems: RHK4 12.4-12.6, KK 6.5, pp. 253-255.

PSR Fellows, who are advanced Physics Majors, are available to help you in the PSR Wed. & Thurs. from 6-8pm, and Sunday in 1640 Broida, 6-8pm.

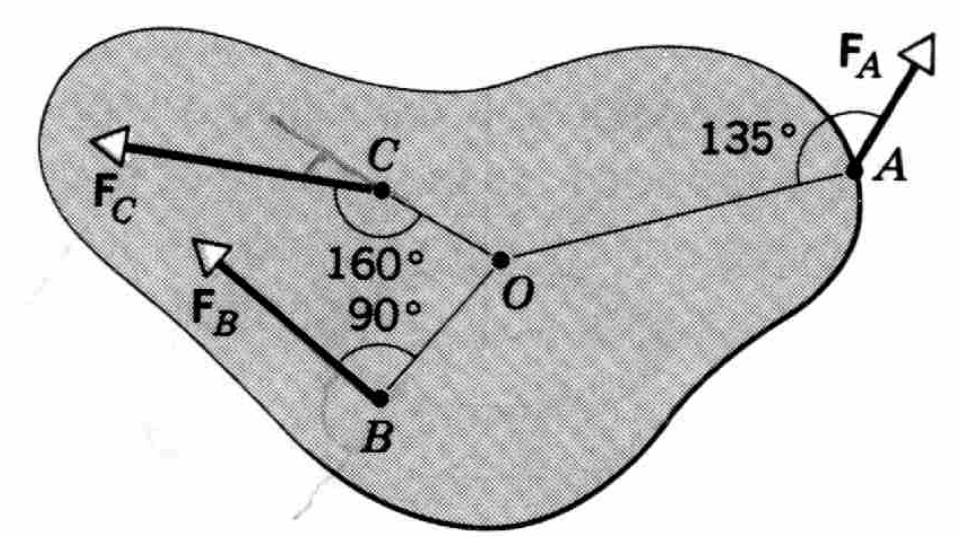


Figure 1: Problem 1.

1. The object shown in Fig. 1 is pivoted at $O$. Three forces act on it in the directions shown on the figure: $F_A = 10\,\mathrm{N}$ at point $A$, 8.0 m from $O$; $F_B = 16\,\mathrm{N}$ at point $B$, 4.0 m from $O$; and $F_C = 19\,\mathrm{N}$ at point $C$, 3.0 m from $O$. What ar the magnitude and direction of the resultant torque about $O$? (RHK4 12.17)

2. In the act of jumping off a diving board, a diver changed her angular velocity from zero to 6.20 radians/second in 220 milliseconds, with a constant angular acceleration. Her rotational inertia is 12.0 kg·m$^2$. (RHK4 12.21)

   (a) Find her angular acceleration $\alpha$ during the jump.

   (b) What external torque acted her during the jump?

3. A hoop of radius $R = 3.16\,\mathrm{m}$ has a mass of 137 kg. It rolls along a horizontal floor so that its center of mass has a speed of 0.153 m/s. How much work must be done on the hoop to stop it? (RHK4 12.44)

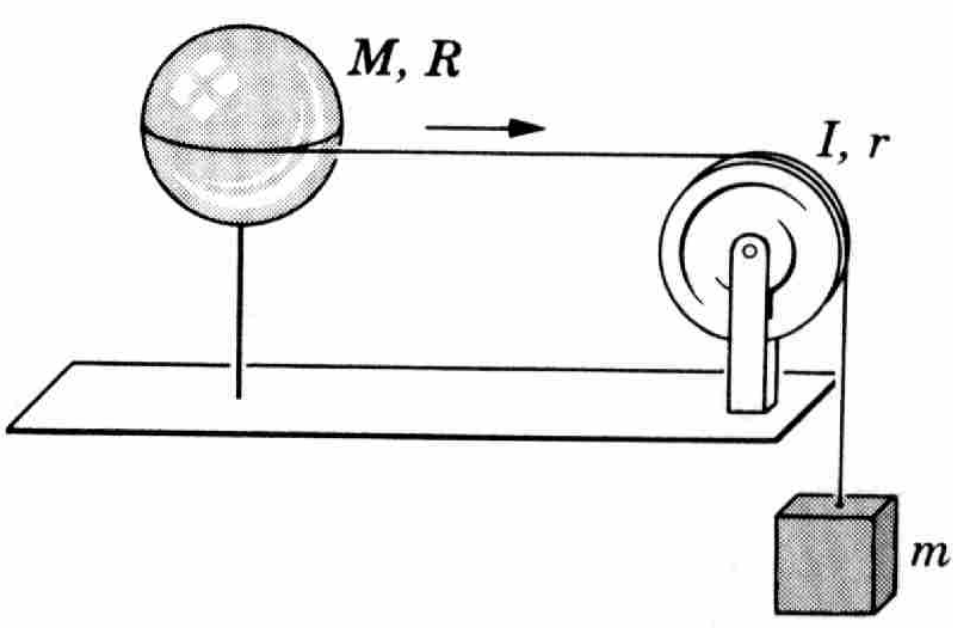


Figure 2: Problem 4.

4. A uniform sphere (solid, not just a shell) rotates about a vertical axis on frictionless bearings (Fig. 2). A light (assume massless) cord passed around the equator of the ball, over a pulley, and is attached to a small mass that falls freely due to gravity. What is the speed of the object after it has fallen a distance $h$ from rest in terms of the various quantities enumerated on the figure? (RHK4 12.34)

5. A homogenous sphere starts from rest at the upper end of a track shown in Fig. 3 and rolls without slipping until it rolls off the right-hand end. The track becomes horizontal at the right hand edge, and the initial height is $H = 60\,\mathrm{m}$

   (a) The final height is $h = 20\,\mathrm{m}$. Determine the distance $x$ to the right of point $A$ at which the ball strikes the horizontal base line.

   (b) Imagine changing the final height $h$. Which value of $h$ achieves the maximum $x_m$ distance to the right of point $A$ at which the ball strikes the base line, and, evaluated $x_m$ numerically.

6. K&K 6.27.

7. K&K 6.28

8. A billard ball of uniform mass density is struck by a cue as in Fig. 4. The line of action of the applied impulse is horizontal and passes through the center of the ball. The initial velocity component $v_0$ of the ball, its radius $R$, its mass $M$, and the coefficient of kinetic friction $\mu_k$ between the ball and the table are all known. As the ball is struck by the pool cue, it does not rotate at all. After the 'strike' by the cue is over, how far will the ball move before it ceases to slip, and begins too roll on the table? Give a symbolic answer in terms the quantities discussed. Also, it is a good idea to check that the distance you get is *shorter* that the distance (which should be easy to work out) that it would take to totally stop a non-rotating block with the same $v_0$ and $\mu_k$.

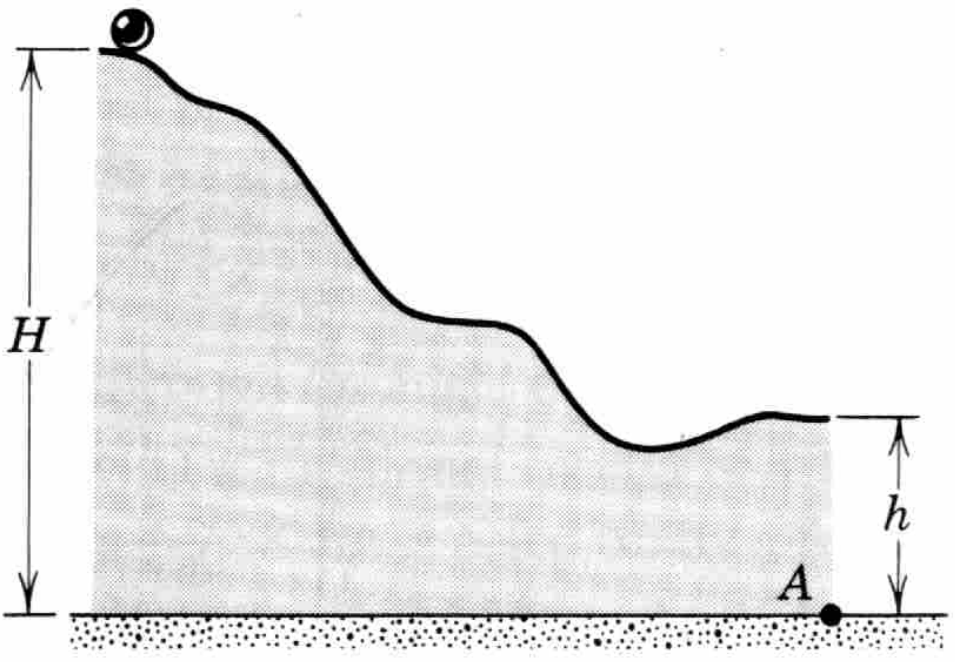


Figure 3: Problem 5.

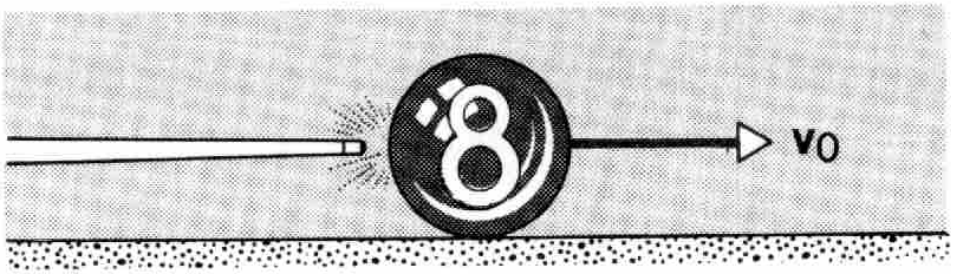


Figure 4: Problem 8.