Phys 3610, Fall 2008
Problem Set #2, Hint-o-licious Hints

1. *Taylor*, **2.31** Find $v_{\rm ter}$ using $c = \gamma D^2$. Get the time to fall from (2.58) with $y = 30$ m and then v from (2.56).

2. *Taylor*, **2.38** The equation of motion for the trip upward (y axis points upward) is

$$m\frac{dv}{dt} = -mg - cv^2$$

Do the usual separation of variables and do the integration. Here you can integrate the t side from $t' = 0$ to $t' = t$ and the v side from $v' = v_0$ to $v' = v$. This will give an arctangent function of v. Do some algebra to get it into the desired form.

3. *Taylor*, **2.41** Now we want to throw the baseball upward but solve the differential equation in the variables v and y using

$$\frac{dv}{dt} = \frac{dx}{dt}\frac{dv}{dx} = v\frac{dv}{dx}$$

Here the integral gives a log function.

4. *Taylor*, **2.42** Now do the downward journey in the variables v and y. (In the chapter it was done in term of v and t.) When we consider the cases of "very little" and "very much" air resistance, we mean that $v_0 \ll v_{\rm ter}$ (little) or $v_0 \gg v_{\rm ter}$ (much).

5. *Taylor*, **3.14** After using $m = m_0 - kt$, the equation you want to solve has the form

$$(m_0 - kt)\frac{dv}{dt} = kv_{\rm ex} - bv$$

solve by the usual separation of variables. (Get logs then exponentiate these.) When you get an equation with a constant to determine, apply the condition $v = 0$ at $t = 0$ to fix the constant. Do some algebra to get it into the desired form; you can substitute m for $m_0 - kt$.

6. *Taylor*, **3.22** Since it is clear that the center of mass is on the symmetry axis of the hemisphere, we just need its z coordinate, which is given by

$$\frac{1}{M}\int z\rho d\tau \qquad \text{with} \qquad z = r\cos\theta$$

. and M is the mass of the *hemisphere*. The density is

$$\rho = \frac{M}{\frac{2}{3}\pi R^3}$$

7. *Taylor*, **3.25** The point here is that since the force on the particle is necessarily along the length of the string and toward the origin, there is no torque on it, and its angular momentum is conserved (its energy however is not).

8. *Taylor*, **3.32** In the usual spherical coordinates, the distance of an element of the sphere from the axis is $r\sin\theta$. The mass element is $\rho r^2 dr \sin\theta d\theta d\phi$ and the density of the sphere is

$$\rho = \frac{M}{\frac{4}{3}\pi R^3}$$

9. *Taylor*, **3.35** Just do parts (a) and (c). It turns out that for a very subtle reason, the approach of part (b) is simple but *unjustified*. It's a frequent error people make when solving problems of rolling motion. However one *can* justify an axis at the point of contact with a rather obscure theorem in mechanics (which we won't do).