Physics CS 31 **Fall 2010**

Set #4 - for Wd Oct. 20

Read HR&K	Ch. 4 and Ch. 3 - Sects. 3.1 through 3.5
Read K&K	Ch. 1 - Sects. 1.8, 1.9 and Note 1.1 (p. 39-47)
Read Feynman Vol. 1	Ch. 5, 8 & Ch. 9

From HR&K: Ch. 4 Exercise 15, 19. Problems 10, 21, 23.

From K&K: Ch. 1 Problems 1.15, 1.18, 1.20, 1.21.

1. Consider a projectile launched from level ground. Find the launch angle $\theta_{\rm o}$ for which the projectile traces the maximum trajectory length. Ignore air resistance.

2. Consider projectile motion with air resistance, $\vec{a}_{\rm res} = -k\vec{v}$, $k > 0$. Using the expressions for $x(t)$ and $y(t)$ derived in class:
a) Show that the maximum altitude reached is

$$y_{\rm max} = \frac{v_{\rm o}}{k}\sin\theta_{\rm o} - \frac{g}{k^2}\ln(1 + \frac{k}{g}v_{\rm o}\sin\theta_{\rm o}).$$

b) Show that the expression above reduces to $y_{\rm max} = \frac{{v_{\rm o}}^2}{2g}\sin^2\theta_{\rm o}$ for the case of no air resistance.
c) Find $x_{\rm max}$, the maximum horizontal distance.

3. A particle is projected vertically upward in a constant gravitational field with an initial velocity $v_{\rm o}$. There is a retarding force $F_{\rm ret} = -mkv^2$, where m is the mass of the particle.
a) Use $a = \frac{dv}{dt} = v\frac{dv}{dy}$. Integrate to get $y(v)$ during the ascending phase of the motion. Show:

$$y_{\rm max} = \frac{1}{2k}\ln(1 + \frac{{v_{\rm o}}^2}{{v_{\rm T}}^2}), \quad \text{where } {v_{\rm T}}^2 = \frac{g}{k}.$$

b) Similarly integrate during the descending phase of the motion and show that the particle returns to the initial position (ground) with velocity

$$v_f = \frac{v_{\rm o}v_{\rm T}}{\sqrt{v_{\rm o}^2 + v_{\rm T}^2}}.$$

What is the physical meaning of v_{T}?

c) Does it take longer to go up or to come down? Explain without using equations.

4. Use the subscript notation and show the following identities:

a) $(\vec{A} \times \vec{B}) \cdot (\vec{C} \times \vec{D}) = (\vec{A} \cdot \vec{C})(\vec{B} \cdot \vec{D}) - (\vec{A} \cdot \vec{D})(\vec{B} \cdot \vec{C})$

b) $(\vec{A} \times \vec{B}) \times (\vec{C} \times \vec{D}) = \vec{B}[\vec{A} \cdot (\vec{C} \times \vec{D})] - \vec{A}[\vec{B} \cdot (\vec{C} \times \vec{D})]$

c) $\vec{A} \times [\vec{B} \times (\vec{C} \times \vec{D})] = (\vec{A} \times \vec{C})(\vec{B} \cdot \vec{D}) - (\vec{A} \times \vec{D})(\vec{B} \cdot \vec{C})$