Physics CS 31

Set #4 - for Wednesday October 23

Fall 2013

Read RHK Ch.4, Ch 3 (3.1 – 3.5)
K&K Ch.1 (1.8, 1.9, and Note 1.1)
Feynman V.1 Ch. 5, 8 & 9

Solve

From RHK	Ch. 4	Exercise 15, 19. Problems 8, 10, 21, 23
From K&K	Ch.1	Problems 1.15, 1.18, 1.20, 1.21

Problem 1. Consider projectile motion with air resistance, $\vec{a}_{res} = -k\vec{v},\ \ k > 0$. Using the expressions for $x(t)$ and $y(t)$ derived in class:

a) Show that the maximum altitude reached is

$$y_{\max} = \frac{v_0}{k}\sin\theta_0 - \frac{g}{k^2}\ln\left(1 + \frac{k}{g}v_0\sin\theta_0\right).$$

b) Show that the expression above reduces to $y_{\max} = \frac{v_0^2}{2g}\sin^2\theta_0$ for the case of no air resistance.

c) Find $x_{\max}$, the maximum horizontal distance.

Problem 2. Use the expressions for $x(t)$ and $y(t)$ derived in class to plot the graph for projectile trajectory without and with air resistance $\vec{a}_{res} = -k\vec{v},\ \ k > 0$. Select and use initial velocity and two different values of k. Use the same initial point and the same value of the initial velocity for all three curves. Plot all your graphs on the same picture to compare them. Use computer. Mathematica is available for the students in PSR (Broida).

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Problem 3. A particle is projected vertically upward in a constant gravitational field with an initial velocity v_0. There is a retarding air resistance $a_{res} = kv^2$.

a) Use $a = \frac{dv}{dt} = v\frac{dv}{dy}$. Integrate to get $y(v)$ during the ascending phase of the motion. Show:

$$y_{\max} = \frac{1}{2k}\ln\left(1 + \frac{v_0^2}{v_T^2}\right).$$

b) Determine the value and explain the physical meaning of v_T. Integrate during the descending phase of the motion and show that the particle returns to the initial position (ground) with velocity

$$v_f = \frac{v_0 v_T}{\sqrt{v_0^2 + v_T^2}}$$

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

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

Good Luck, Dr. B