PHYS 3340
Spring 2008
TE Coan
Due: 5 May '09, 6pm via email.

Homework 9

1. In introductory physics classes we typically ignore the effects of friction when describing motion. This perhaps strikes you as a bit of a dodge. To perhaps partially allay your suspicion that we are up to no good, consider the effects of air friction on motion through air.

A parachutist of mass 70 kg jumps from a plane at an altitude of 32 km above earth's surface. Unfortunately, the parachute malfunctions and does not open. (Neglect horizontal motion and assume the initial velocity is zero in the following.)

(a) Calculate the time of fall (accurate to 1 second) until ground impact, assuming no air resistance and a constant value of acceleration $g = 9.8\,\mathrm{m/s^2}$.

(b) Calculate the fall time (accurate to 1 second) given constant g and a force of air resistance given by $F(v) = -c_2 v|v|$, where $c_2 = 0.5\,\mathrm{kg/m}$ for our falling parachutist and is constant.

(c) Calculate the fall time (accurate to 1 second), given c_2 scales with atmospheric density as $c_2 = 0.5e^{-y/H}$, where $H = 8\,\mathrm{km}$ is the "scale height" of the atmosphere and y is the height above ground. Furthermore, assume that g is no longer constant but varies as

$$g = \frac{9.8}{(1 + \frac{y}{R_e})}\,\mathrm{m/s^2},$$

where $R_e = 6370\,\mathrm{km}$ is earth's radius.

(d) For part c, plot the velocity and the altitude of the parachutist as a function of time. Explain why the acceleration becomes positive as the parachutist falls.