PHYS 3344
Fall 2019
TE Coan
Due: 13 Sep '19 6:00 pm

Homework 2

1. Suppose you shoot directly downwards some projectile with an initial speed V_0 that *exceeds* its terminal velocity v_{ter}. Assuming that the resistive force is linear, what is the expression for the projectile's speed $v(t)$ as a function time? **Box** your answer. Make a simple plot of $v(t)$. Use a computer so the plot looks nice and I can read it.

2. Suppose you drop a basketball of mass $m = 600\,\mathrm{g}$ and diameter $D = 24\,\mathrm{cm}$.

a) What is its terminal speed V_{ter}?

b) Suppose further it is dropped from a tower of height $H = 30\,\mathrm{m}$. How long T does it take to hit the ground? Compare numerically to the case of falling in vacuum.

c) How fast v_f is it going when it strikes the ground? Compare numerically to the case of falling in a vacuum.

3. Consider some object coasting horizontally in the positive x-direction subject to a drag force $f = -bv - cv^2$, where b and c are constants determined by the geometry of the coasting object and the material the object is coasting through.

a) Write down Newton's law for this object and solve for $v(t)$.

b) Sketch the behavior of v as a function of time t. Explain the the time dependence at large t, that is, what force term is dominant at large t?

4. Suppose a baseball is thrown directly upwards with an initial speed v_0 and is subject to a drag force of magnitude $f(v) = cv^2$. Define the positive y-direction to be upwards.

a) Show that the equation of motion can be written as $\dot{v} = -g[1 + (v/v_{ter})^2]$.

b) Now integrate this using a math trick you saw last homework to determine $y = y(v)$ or $v = v(y)$, whichever is easier for you. Show that the baseball's *maximum* height $y_{\max}$ is

$$y_{\max} = \frac{v_{\mathrm{ter}}^2}{2g} \ln\left(\frac{v_{\mathrm{ter}}^2 + v_0^2}{v_{\mathrm{ter}}^2}\right).$$

5. Expand the function $y = y(x)$ below in a Taylor series about $x = 0$ and keep the first 2 non-zero terms.

$$y(x) = 2 + e^{-x^2}$$