Phys 2112, Spring 2011
Problem Set #2

1. The motion of a particle is given by

$$a(t) = (2\,\tfrac{\mathrm{m}}{\mathrm{s}^2}) + (4\tfrac{\mathrm{m}}{\mathrm{s}^3})t \qquad \text{with} \quad v_0 = -4\,\tfrac{\mathrm{m}}{\mathrm{s}} \quad x_0 = -8\ \mathrm{m}$$

Find $v(t)$ and $x(t)$.

2. The motion of a particle is given by

$$x(t) = (7\ \mathrm{m})\cos(6t+2) \qquad \text{with } t \text{ in seconds.}$$

Find $v(t)$ and $a(t)$.

3. For this problem and the next one we will consider an object which is dropped. For simplicity we'll take the y axis to point downward and the object starts at the origin, from rest.

For a small object like a raindrop the equation for the velocity $v(t)$ is

$$v(t) = (1.3\,\tfrac{\mathrm{m}}{\mathrm{s}})(1-e^{-t/\tau}) = v_{\mathrm{ter}}(1-e^{-t/\tau}) \qquad \text{where} \quad \tau = 0.13\ \mathrm{s}$$

Find $y(t)$ and $a(t)$. Make plots of all functions.

4. If a larger object like a baseball is dropped, there is a different equation for $v(t)$. It is

$$v = (35\,\tfrac{\mathrm{m}}{\mathrm{s}})\tanh\left(\frac{gt}{35\,\frac{\mathrm{m}}{\mathrm{s}}}\right) = v_{\mathrm{ter}}\tanh\left(\frac{gt}{v_{\mathrm{ter}}}\right)$$

with $v_{\mathrm{ter}} = 35\,\frac{\mathrm{m}}{\mathrm{s}}$. Again, find $y(t)$ and $a(t)$. Make plots.

5. As you'll soon learn, an object has a constant acceleration when it undergoes a constant force, in which case its velocity increases uniformly. Relativity says that the velocity cannot increase indefinitely; it can never equal the speed of light, c.

When we use the right relativistic equations we find that when an object starts from rest and experiences a force equal to the force of gravity, its velocity is given by

$$v(t) = \frac{(9.8\,\frac{\mathrm{m}}{\mathrm{s}^2})t}{\sqrt{1+\left(\frac{9.8\,\frac{\mathrm{m}}{\mathrm{s}^2}\,t}{c}\right)^2}}$$

which differs from the non-relativistic formula $v(t) = 9.8\,\frac{\mathrm{m}}{\mathrm{s}^2}\,t$.

Find $x(t)$ and $a(t)$.

You'll note that relativity makes things more complicated!
