Physics 321 – Spring 2017

Homework #7, due at beginning of class Wednesday Mar 1.

1. [4 pts] You are designing a roller-coaster. One section of the track will be advertised as "The Loop." The shape of the track is defined parametrically by the equations

$$\begin{aligned} x &= [u/2 + \sin(u)]\, H/2 \\ y &= [1 - \cos(u)]\, H/2 \\ z &= 0 \end{aligned}$$

where y is the height above ground and $0 < u < 2\pi$. Find the force due to the track on the car of mass M when the car reaches its maximum height H at $u = \pi$, ignoring friction. Assume the car starts at $u = 0$ with speed v_0. *(This design probably needs some adjustment to improve the safety of the passengers: the initial velocity must be sufficient to carry the car over the top, which makes the acceleration at the beginning of the track at least* $2.77\,g$*.)*

2. [4 pts] Solve the differential equation

$$\frac{\mathrm{d}x}{\mathrm{d}t} = \frac{2x + 1}{t + 2}$$

to find x as a function of t, given that $x = 0$ at $t = 0$. (This problem does not come from any physics problem, but it's a good example to practice your equation-solving skills on!)

3. [4 pts] The position of a point particle is governed by the equation of motion

$$\ddot{x} + Ax = B$$

where A and B are constants. It starts at $x = 0$ with $\dot{x} = v_0$ at $t = 0$.

   (a) Find x as a function of time t assuming $A > 0$.

   (b) Find x as a function of time t assuming $A < 0$.

4. [4 pts] Taylor problem 4.2

5. [4 pts] Taylor problem 4.36

(Last updated 2/22/2017.)