The University of Alabama at Birmingham (UAB)
Department of Physics

PH 461/561 – Classical Mechanics I – Fall 2005

Assignment # 11 Due: **Thursday, Dec. 1**
(Turn in for credit!)

Activities in preparation for Dec. 1 lecture:

1. A particle of mass m with initial speed v_0 at $t = -\infty$ is acted upon by a time dependent impulsive force given by:

$$F(t) = \frac{I_0 \delta t}{\pi} \frac{1}{(t - t_0)^2 + (\delta t)^2}; \qquad \text{for} \quad -\infty < t < \infty$$

where I_0 and t_0 are positive constants and δt is a very small (positive) time interval compared to the total travel time of the particle.

   a. Graph the force $F(t)$ indicating explicitly on your graph the meaning of the various parameters that appear on the expression above.
   b. Calculate the total impulse delivered by $F(t)$ to the particle.
   c. What is the final speed of the particle at $t \to \infty$?
   d. Apply this model force, $F(t)$, to the case of an elastic collision of the particle with a rigid wall. Assuming m = 0.1 kg, v_0 = 10 m/s, and a collision time δt = 0.001 s, estimate the magnitude of the force experienced by the particle due to the impact. Compare the value you found with the weight of the particle.

2. A particle of mass m moves in a plane subjected to a force that may be expressed as follows:

$$\mathbf{F} = -k\mathbf{r}$$

where k is a constant and $\mathbf{r}$ is the position vector of the particle with respect to the origin.

   a. What can you say about the total mechanical energy of this particle? (Show explicitly how you support your answer).

   b. Determine the equations of motion of the particle in the Cartesian coordinate system.

c. Determine the trajectory of the particle if it is set in motion with the following initial conditions:

$$\mathbf{r_0} = \mathbf{i}x_0 \text{ (i.e., } x_0 \text{ along the } x\text{-axis)}$$
$$\mathbf{v_0} = \mathbf{j}v_0 \text{ (i.e., } v_0 \text{ along the } y\text{-axis)}$$

This same particle is now given an electrostatic charge q and a weak uniform magnetic field $\mathbf{B}=B_0\mathbf{k}$ (i.e., perpendicular to the plane of motion) is applied to the system. [Please note that the particle is now subject to $\mathbf{F} = -k\mathbf{r}$ and the magnetic force resulting from the applied magnetic filed **B**.]

d. Write the new equations of motion for the particle.

e. Find and discuss the new trajectory of the particle once the magnetic field has been turned on.