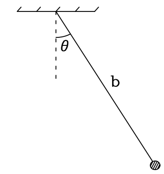
PHYSICS 321 EXAM 1 Feb 16, 2005 NAME ____________________

1. [3 pts] The location of a particle of mass M is given by

$$\vec{\mathbf{r}} = C_1 \cos(\omega\, t)\, \hat{\mathbf{i}} + C_2\, e^{B\,t}\, \hat{\mathbf{j}} + C_3\, t^3\, \hat{\mathbf{k}}$$

as a function of the time t, where C_1, C_2, C_3, B, and ω are constants. Find the component of force in the tangential direction.

2. A mass M is attached to the ceiling by a massless string of length b. The mass is swinging back and forth, so θ is a function of time. Your answer to each question should contain some or all of the following: θ, $\dot{\theta}$, $\ddot{\theta}$.



(a) [2 pts] Write down the kinetic energy.

(b) [2 pts] Write down the angular momentum about the point where the string is attached to the ceiling.

(c) [3 pts] Use the radial component of $\vec{F} = M\,\vec{a}$ to find the tension in the string.

(d) [3 pts] Use the tangential component of $\vec{F} = M\,\vec{a}$ to find the equation of motion which relates $\ddot{\theta}$ to θ.

3. [5 pts] Suppose that the friction force on an object of mass M travelling through a fluid is proportional to the cube of the velocity: $F = -K\,v^3$, where K is a constant. Find the velocity as a function of time, assuming that the initial velocity is v_0 at time $t=0$. Neglect gravity.

4. A chain with length b and uniform mass density ρ is tightly coiled up on the floor. One end of the chain is lifted straight up at a rate such that the height of that end above the floor is given by $x = K\,t^3$, where K is a constant.

   (a) [4 pts] Find the total force on the chain as a funtion of time t.

   (b) [4 pts] Find the height of the center of mass of the entire chain as a function of time t.

   (c) [4 pts] Find the work done by the hand as a function of time t.