PHY 5246: Theoretical Dynamics, Fall 2011

September 30th, 2011
Assignment # 5
(Graded problems are due Friday October 14th, 2011)

1 Graded problems

1. Consider a particle that moves in a logarithmic spiral orbit given by $r = ke^{\alpha\theta}$, where k and α are constants.

    (1.a) Find the force law that allows the particle to move in this orbit.

    (1.b) Determine $r(t)$ and $\theta(t)$.

    (1.c) What is the total energy of the orbit?

2. A particle of mass m moves in a potential given by $V(r) = \beta r^k$, where β and k are constants. Let the angular momentum be l.

    (2.a) Find the radius r_0 of the circular orbit.

    (2.b) If the particle is given a tiny kick so that the radius oscillates around r_0, find the frequency, ω_r, of these small oscillations in r.

    (2.c) What is the ratio of the frequency ω_r to the frequency of the (nearly) circular motion, $\omega_\theta = \dot{\theta}$? Describe the cases: $k = -1, 2, 7, -\frac{7}{4}$, for which the ratio ω_r/ω_θ is rational, that is, for which the path of the nearly circular motion closes back on itself. Can you roughly plot the orbits for these four cases?

3. Chapter 3, Problem 11 of your Textbook.

4. Chapter 3, Problem 14 of your Textbook.

2 Non-graded suggested problems

5. Chapter 3, Problem 10 of your Textbook.

6. Chapter 3, Problem 19 of your Textbook.