

PHY 3221 : Intermediate Mechanics, Spring 2003

March 7th, 2003

Assignment # 9

(due Friday March 21st, 2003, at the beginning of class)

1. A block of mass m is attached to a massless spring with spring constant k . The other extremum of the spring is attached to a fixed pivot on a frictionless horizontal table. Imagine to slightly displace the block from its equilibrium position in an arbitrary direction in the plane of the table (give your answer in plane polar coordinates (r, θ) with origin at the pivot).
 - (a) What is the force $\mathbf{F}$ on the block and what potential does the block move in?
 - (b) Show by direct calculation that the magnitude of the angular momentum of the block is $l = mr^2\dot{\theta}$. Is the angular momentum conserved? Why?
 - (c) Find the total energy $E = T + U$ in terms of the radial coordinates $(r, \dot{r})$, and so find the effective potential for the radial motion $V_{eff}(r)$. Plot $V_{eff}(r)$ and discuss the kind of motion you may expect for this system.
 - (d) Show that the system has a stable circular orbit.
 - (e) If $r = r_0$ is the values of the radius of the stable circular orbit of the system, show that for a small radial displacement about r_0 (i.e. for $r_0 \rightarrow r_0 + x$, with x small) the radial motion of the system is simple harmonic. Find the frequency of the harmonic oscillations.
2. Problem 8.10 of Marion and Thorntons's book.
3. Problem 8.21 of Marion and Thorntons's book.
4. Problem 8.23 of Marion and Thorntons's book.
5. Problem 8.24 of Marion and Thorntons's book.
6. **For graduates** (bonus for undergraduates).
Problem 8.26 of Marion and Thorntons's book.
7. **For graduates** (bonus for undergraduates).
Problem 8.15 of Marion and Thornton's book.