Comments for some of the problems

Version of June 9, 2011

Note: some of the misprints have been corrected in later printings (but they all are the third edition)

There is also a website with misprints of the book:
`http://astro.physics.sc.edu/Goldstein/`

A general comment: read the chapter *before* solving the problems, this will save you a lot of time.

1.9 The factor $1/c$ should not be there.

1.21 Note that this is really a two dimensional problem. The mass m_1 can move on the surface of a table, not just along a line.

You might want to think a bit more about this problem after finishing the central force chapter.

2.13 The resulting equations cannot be easily solved but energy conservation provides a useful extra relation, and remember the hint about reading the chapter properly first. The hoop is fixed (implicitly assumed in the question).

3.16 There are many ways to solve this problem but remember that for a point on an ellipse the sum of the distances to the two foci (focal points) is equal to $2a$, i.e. $r_1 + r_2 = 2a$ and the distance between the two foci is $2ea$.

3.21 There are several ways to solve this one, the basic idea is to show that in the rotating frame you get the same equations as for the $V(r) = -k'/r$ potential, with k' not necessarily the same as k. Note that the frame does *not* have to rotate uniformly. I solved it starting from the orbit equation.

3.31 Follow the same steps as in the chapter for the $1/r$ potential, and just as in that case, using $u = 1/r$ makes the integral easier.

4.15 Again, just remember to read the chapter first.

4.23 The easiest solution is to think properly about the properties of $\vec{\omega} \times \vec{v}$. But be sure to explain your reasoning correctly if you do this.

Otherwise, choose an x and y axis in the plane tangent to the earth surface and a harmonic oscillator in this plane.

5.6 For part (c) an outline of the argument is sufficient.

5.27 Again, remember to consult the chapter closely. The nutation is small here so if you read the description of the possible approximations on page 227 you can expand the $V(\cos\theta)$ around $\cos\theta_0$ via $V(\cos\theta) = V(\cos\theta_0) + V'(\cos\theta_0)(\cos\theta - \cos\theta_0) + \cdots$. Dropping the irrelevant constants then gives you a potential of the same form as in (5.51') but with a different meaning of the constants. So essentially you can again start from (5.52).

6.4 The part about the "beats" is rather involved in the expressions. It becomes much easier if you go to normal coordinates first where it is essentially the two degree of freedom problem with equal masses solved in the chapter.

6.13 Remember that it is sufficient to set up the equations, you do not need to do the diagonalization of the matrices. Which is the equilibrium point you expand around?

9.6 Note that the different ways of checking it require very different amounts of work.

10.16 The action angle variables are defined by (10.82). p_ϕ can be easily expressed in terms of α. The maximum angle in terms of α follows from using the Hamiltonian at that point with $p_\phi = 0$.

12.6 The solution can be found in Chapter 7, but beware of misprints.

12.8 The integral that appears can be performed but is somewhat tricky. You might find $\int \frac{\cos\phi}{(1+e\cos\phi)^3} d\phi = \frac{-3e\pi}{(1-e^2)^{5/2}}$ useful. The general solution is not much more difficult but you are allowed to assume the orbit is in the xy plane. The definition of the J_i needed can be found in Sect. 10.8 in the book. Note that you need to rewrite *all* orbit parameters, e, ℓ and τ, in the J_i.

Note that the orientation of the ellipse w.r.t. x axis is free.