PHYS 3344
Fall 2019
TE Coan
Due: 15 Nov '19 6:00 pm

Homework 9

1. An Earth satellite has a perigee of 300 km and an apogee 3,500 km above Earth's *surface*. How far is the satellite above Earth's surface when

a) it has rotated 90° around Earth from perigee?

b) it has moved halfway from perigee to apogee?

Note: These are different questions since the origin of the orbit coordinate system is not the center of the ellipse. Do box your answers.

2. Another Earth satellite moves in an elliptical orbit with a period T, eccentricity ϵ and semimajor axis a. Show that the maximum radial velocity $v_r^{\max}$ of the satellite is $v_r^{\max} = 2\pi a\epsilon/(T\sqrt{1-\epsilon^2})$.

3. Assume Earth's orbit is circular (a good approximation) and that the Sun's mass suddenly decreases by half. Yikes! Will Earth escape the solar system and what type of orbit (circular, elliptical, parabolic or hyperbolic) will it have? Show your work to receive credit. Box answers.

4. So far, we have only investigated orbits where the force is attractive between the two particles. However, we can consider the case where the force is *repulsive*, such as a proton interacting with another proton through the Coulombic force you learned about in introductory physics. Both the videos and sections 8.6 and 8.7 in the text can guide you to determine what the orbit equation should be for this case. (It will be similar, but not identical to what we derived for the case of an attractive force.) One way to proceed is to write the force between the two particles as $F(r) = +\gamma/r^2$ and to appropriately adjust the sign in front γ in subsequent equations so that γ is always a positive quantity. You can assume that $l \neq 0$.

a) Show that this system has *no* states with total energy $E < 0$ (as measured in the CM frame).

b) Show that for all states with $E > 0$, the relative motion follows a hyperbola. Remember that box. Sketch the orbit.