PHYS 3344
Fall 2017
TE Coan
Due: 5 Dec '17 6:00 pm

Homework 8

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. A projectile is launched due east from a point on Earth's surface at a northern latitude λ and at an angle of inclination to the horizontal α. Its launch speed is V_0. Show that the lateral deflection d when the projectile strikes Earth is

$$d = \frac{4V_0^2}{g^2}\,\omega \sin\lambda \sin^2\alpha \cos\alpha,$$

where ω is Earth's rotation frequency.

5. Assume Earth is spherical. Calculate the difference Δg in the gravitational acceleration g near the surface at the equator g_{equator} and the poles g_{poles}. Use mm/sec^2 as your unit for Δg. The actual value, given in class, is slightly larger due to bulging around the equator.

6. The last homework problem for PHYS 3344! Show that if a driven oscillator is only lightly damped and driven near resonance, The Q of the system is given by

$$Q = 2\pi \left(\frac{\text{Total energy}}{\text{Energy loss in one period}} \right).$$

Recall that the power P_{friction} lost due to friction acting on an object is given by $P = Fv$, where F is the frictional force on the object and v is the object's speed, assuming the force and the object's velocity are aligned. Ignore the transient piece of the solution for the displacement of a driven oscillator.