PHYS-3202 Homework 11 Due 6 Dec 2023

This homework is due to `https://uwcloud.uwinnipeg.ca/s/H4t44ogzdTkskyD` by 10:59PM on the due date. Your file(s) must be in PDF format; they may be black-and-white scans or photographs of hardcopies (all converted to PDF), PDF prepared by LaTeX, or PDF prepared with a word processor *using an equation editor*.

1. **Deflection of Thrown Object** *partly based on Cline 12.1 and other sources*

   Consider motion near the surface of the earth. The rotational frequency of the earth is ω, and θ is the colatitude.

   (a) Suppose I throw a ball straight upward with initial velocity v. Show that it lands west of me and determine how far in terms of v, the angular velocity of the Earth, and the latitude. Use the same approximations as in the class notes on the deflection of a falling object. *Hint*: You need to introduce an initial velocity to the formula derived in class. You can also see Cline example 12.7.

   (b) Suppose I throw the ball at an angle α from the vertical toward the east with initial speed v. Show that the Coriolis force deflects the trajectory $(4\omega v^3/g^2)\sin\lambda\sin^2\alpha\cos\alpha$ south compared to where it would land without the Coriolis effect (in addition to the westward deflection we discussed in the first part of the problem).

2. **Octant of a Sphere** *based on Fowles & Cassiday*

   Consider a solid object of uniform density and mass M in the shape of one octant of a solid sphere of radius a. That is, it consist of all points with $r \le a$ and $x > 0, y > 0, z > 0$. Find the inertia tensor for rotations around the origin. *Hint:* Although the tensor is given in Cartesian coordinates, the integrals can still be carried out in spherical polar coordinates. You can also use symmetry to reduce your calculations.