PHYS 703 HW #1

August 2014

1. [10 points]

   Derive as many of the vector relations on the inside front cover and facing page of the text by Jackson (Third Edition) as you can.

2. [10 points]

   Do as many of the following as you can:

   - (a) A square column of water has sides of length a, height h, and a wavy bottom. The bottom surface is bounded by the x and y axes and by the lines $x = a$ and $y = a$. It sits above the x-y plane and is described by a height
   $$z(x, y) = b \sin(\pi x/a) \sin(\pi y/a)$$
   Find the net force on the bottom surface.
   - (b) A hollow metal sphere of radius R is filled with water but has a small opening at its "North Pole". There is a door on the side of the sphere that lies between $\theta = \theta_1$ and $\theta = \theta_2$, and between $\phi = \phi_1$ and $\phi = \phi_2$. The door is hinged at $\phi = \phi_2$ but otherwise locked shut. Find the net force and opening torque on the door due to water pressure.
   - (c) A cylindrical column of water has radius R and water height h. The cylinder is open to the atmosphere and is much taller than the water column. To start with, the bottom surface of the cylinder is coincident with the x-y plane and the z-axis forms the cylindrical axis. There is a door on the side of the cylinder that lies between $z = z_1$ and $z = z_2$, and between $\phi = -\phi_0$ and $\phi = \phi_0$. The door is hinged at $\phi = \phi_0$ but otherwise locked shut. The cylinder is rotated around the y-axis by a small angle $\theta = \theta_0$. Find the net force and opening torque on the door due to water pressure.
   - (d) Griffiths problem 1.61.
   - (e) If $\vec{a}$ is a constant vector, find the integral over the surface of a sphere of the quantity $\hat{r}(\vec{a} \cdot \hat{r})$.