Climate Physics

Problem Assignment #2

1. Show that

$$-\vec{\Omega} \times \vec{\Omega} \times \vec{r} = \nabla \left(\frac{\Omega^2 r^2}{2} \right)$$

2. Consider a puck moving on a frictionless parabolic surface that is rotating at a constant angular velocity Ω. In the rotating reference frame, the 2-d equations of motion can be expressed as

$$\frac{du_{rot}}{dt} = 2\Omega v_{rot} \tag{1}$$

$$\frac{dv_{rot}}{dt} = -2\Omega u_{rot} \tag{2}$$

where $u_{rot} = dx/dt$ and $v_{rot} = dy/dt$, in a Cartesian coordinate system fixed in the rotating frame with the origin at the axis of rotation. If the puck is initially located at the origin ($x(0) = y(0) = 0$) and is "kicked" toward the y-direction with speed v_0 ($u_{rot}(0) = 0$; $v_{rot}(0) = v_0$), solve for the motion of the puck in the rotating reference frame. (*Hint: show equation 6.35 holds.*) Draw the motion of the puck in the rotating frame.

3. Marshall & Plumb problem 6.1 (chapter 6 problem 1).

4. Marshall & Plumb problem 6.2.

5. Marshall & Plumb problem 6.4.

6. Marshall & Plumb problem 6.6.

7. Marshall & Plumb problem 6.7.