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Problems set # 5 **Physics 411** October 11, 2007

1. A bucket of water is spinning about its symmetry axis. Determine the shape of the water in the bucket.

2. Find the horizontal deflection from the plumb line caused by the Coriolis force acting on a particle falling freely in the Earth's gravitational field from a height h above the Earth's surface.

3. If a particle is projected vertically upward to a height h above a point on the Earth's surface at northern latitude λ, show that it strikes the ground at a point

$$\frac{4}{3}\Omega \cos\lambda\sqrt{8h^3/g}$$

to the west (neglect air resistance and consider only small vertical heights.)

4. If a projectile is fired due east from a point on the surface of the Earth at a northern latitude λ with velocity of magnitude v_0 and at an angle of inclination to the horizontal of α, show that the lateral deflection when the projectile strikes the Earth is

$$d = \frac{4v_0^3}{g^2}\,\Omega\,\sin\lambda\,\sin^2\alpha\,\cos\alpha\ ,$$

where Ω is the rotation frequency of the Earth.

5. In the preceding problem, if the range of the projectile is R_0 for the case $\Omega = 0$, show that the change of range due to the rotation of the Earth is

$$\Delta R = \sqrt{\frac{2R_0^3}{g}}\ \Omega\ \cos\lambda\ \left(\cot^{1/2}\alpha - \frac{1}{3}\ \tan^{3/2}\alpha\right)\ .$$