Practice Problems for Dynamics in Rotating Frames

3. Consider a horizontal turntable, rotating about a vertical axis passing through its center, with angular velocity $\omega_1 \hat{z}$. An observer on this turntable, see a mass m on the turn table in uniform circular motion with angular velocity $\omega_2 \hat{z}$, at a radius R from the center of the turntable. The friction between the turntable and the mass is the **Physical Force** in this problem. Calculate this force by analyzing the motion of m from the frame of (a) an the observer on the turntable and (b) an inertial observer.

2. Consider a horizontal turntable, rotating with about a vertical axis passing through its center, with angular velocity $\omega \hat{z}$. It has a groove cut from its center to its edge along the radial direction. A mass m moves with uniform velocity $v_0 \hat{r}$, along the groove, where $\hat{r}$ is the radial unit vector in the rotating frame. Identify the physical forces, both in radial (r) and tangential (θ) direction, which enable the mass to maintain the above motion.

3. A tank on equator, shoots a shell with a speed of 100 m/s at a target one km away. What should be the angle of the initial velocity of the shell, with respect to the horizontal, if the shell is to hit the target? Take g to be 10 m/s^2. The horizontal component of the velocity of the shell is **tangential** to the equator and points towards east. The angular velocity of earth is 7.3×10^{-5} rad/sec. Calculate the component of the Coriolis force in the vertical direction and compare it to the centrifugal force. Are these two forces in the same direction or in opposite directions? Calculate the distance by which the shell will miss the target. Will the shell land beyond target or will it fall short?