DEPARTMENT OF PHYSICS
INDIAN INSTITUTE OF TECHNOLOGY, MADRAS

PH5030 Classical Mechanics **Problem Set 8** **1.10.2021**

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1. Let O be the frame on earth and O' be the frame on a moving train. Make suitable choices for the frames in the following situations. Determine the various terms that appear in the formula for acceleration in both cases.

   (a) The train is moving with in a straight line uniform acceleration.

   (b) The train is moving in a circle of radius R with non-constant angular velocity.

2. Obtain explicit numbers due to the centripetal and Coriolis forces.

   (a) A mass m is dropped from a height of 100m in Chennai (latitude $\ell = +13^\circ$). Estimate the horizontal deflection of the mass due to the Coriolis force. Also estimate the change in g due to the centripetal term.

   (b) Estimate the difference in g_{eff} between the poles and the equator. Compare your estimate with the measured difference of $52mm/s^2$.

   (c) A Foucault pendulum of height 30m is set up in Chennai (latitude $\ell = +13^\circ$). Compute the frequency of precession of the axis of the pendulum. Compare it with the natural frequency of the pendulum. Write a program and create an animation that illustrates this precession.

3. [From Marion-Thornton] If a projectile is fired due east from a point on the surface of the earth at northern latitude ℓ with a speed v_0 at an angle of inclination (to the horizontal) α, show that the lateral deflection due to the Coriolis force when the projectile strikes earth is

$$d = \frac{4\omega v_0^2}{g} \sin\ell \sin^2\alpha \cos\alpha \ ,$$

   where ω is the angular velocity of rotation of the earth. What is the direction of the deflection? If the same experiment were done in the southern hemisphere with the same latitude, what happens to the direction of deflection?