PHYS 306: HOMEWORK ASSIGNMENT No. 6: MOTION IN NON-INERTIAL FRAMES

(March 8th, 2016)

HOMEWORK DUE: Wednesday, MARCH 16th, 2016
To be handed in during class- Late Homework will not be accepted

QUESTION (1) FORCES IN A ROTATING FRAME:

Here we consider a simple problem of a person walking outward on a rotating "merry go round". A person is walking at velocity v directly out along a radial direction from the centre of a "merry go round", which is rotating at angular velocity ω about a vertical axis. We ignore the earth's rotation.

1(a) Find the forces (magnitude and direction) acting on the person as a function of the radial distance r from the centre.

1(b) Suppose the coefficient of static surface friction for the person's shoes is $\mu_s < 1$ (so that the shoes will start to slide when the ratio of horizontal force to downwards force exceeds μ_s). At what value of r will the person no longer be able to continue walking outwards without slipping?

1(c) Suppose the angular velocity $\omega = 1$ rad/sec, that $v = 1ms^{-1}$, and that $\mu_s = 1/2$. Find the value of r at which slippage starts.

QUESTION (2) CORIOLIS FORCE EFFECTS:

The French TGV trains travel at up to 320 km/hr in ordinary service (and up to 575 km/hr in test runs). We consider here a TGV traveling directly north at velocity v on a straight and level (ie., horizontal) track, at a latitude θ. We assume that the centre of mass of the trains is a distance z_o above the rails, and that the rails are at a distance w_o apart. **NB:** here θ is the latitude, ie., measured from the equator, not the polar angle, which is measured from the North pole.

2(a) Show that as a function of the velocity v, the latitude θ, the lengths z_o and w_o, and the angular velocity ω of rotation of the earth, the ratio of the forces on the 2 rails is roughly

$$f_1/f_2 \ \sim \ 1 + (4\omega/g)\frac{z_o}{w_o} v \cos\theta \tag{0.1}$$

2(b) Suppose we assume that $v = 100\ ms^{-1}$ (ie., 360 km/hr) that the latitude is 45^o (ie., the centre of France), that $z_o = 2m$, that $w_o = 1.5m$, and that $\omega = 7.3 \times 10^{-5}$ rads/sec. Find the ratio of the forces.

2(c) At what angle should the tracks be canted or cambered with respect to each other (this is where one rail is lifted up to an elevation above the other), so that the force from the train on the rails is perpendicular to a line crossing between the 2 rails?

END of 6th HOMEWORK ASSIGNMENT