Problem Set 5
Due: 15 June 2023, 4:30 p.m.

Problem 1. Solve Problem 2 (b) and (c) from Problem Set 3 in the non-inertial frame of reference of the moving car.

Please make sure that you have clearly distinguished real forces (due to interactions) and forces of inertia (kinematic corrections due to the fact that the frame of reference is non-inertial).

(*3/2 + 5/2 points*)

Problem 2. A small object with mass m is placed on the inner surface of a container with vertical cross section in the shape of the parabola $y = \frac{1}{2}\alpha x^2$, where $\alpha > 0$. The coefficient of static friction between the object and the pot's surface is μ_s. Find all points such that if we place the object there, it remains at rest.

Consider the following two cases

(a) The container is at rest.

(b) The container rotates with constant angular velocity ω about its axis of symmetry (the object gets in contact with the surface with no relative velocity).

In part (b) clearly identify the frame of reference you are solving the problem in.

(*2 + 4 points*)

Problem 3. Suppose that we have two observers: one at a pole and one on the equator. Assume that over the time of 5 minutes, the rotational motion of the earth was stopped with constant angular acceleration (what is the direction of the angular acceleration vector?). Describe an effect that one observer would see whereas the other one would not.

(*4 points*)

Problem 4. In class, we have seen an example of the effect of the Coriolis force — rotation of the oscillation plane of a swinging pendulum (the Foucault pendulum). A detailed analysis shows that at the geographical latitude of φ, the oscillation plane makes one full turn (360°) over the time $\frac{24 \text{ hours}}{\sin\varphi}$. Find this time for a Foucault pendulum located at the following places and indicate whether the rotation is in the clockwise or counter-clockwise direction (as seen from the suspension point)

(a) Beijing,

(b) Sanya (Hainan province),

(c) Quito (Ecuador),

(d) Ushuaia (Argentina).

(*4 × 1 point*)

Problem 5. Two hunters were hunting at latitude of 49° on the northern hemisphere. One was shooting at a wolf to the west of him, and the other one at a wolf to the south of him. Fortunately, none of them had succeeded and they were both blaming the Coriolis force. Could they have used this excuse? Assume the average speed of the bullet $v_0 = 300$ m/s and the time of flight 1 s.

(*3 points*)