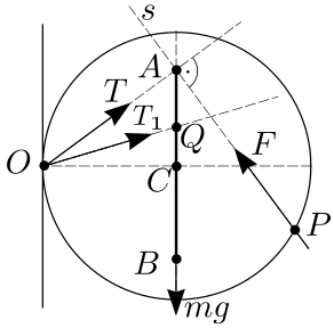
Problem 4. Ball ***(6 points)***



The friction force F_f cannot exceed μN, where N is the normal force. Hence, the resultant vector $\vec{T}$ of those two forces must point to some point Q on the segment AB, the length of which is $2\mu R$, and R stands for the radius of the ball (so that $AC = \mu R$, where C is the ball's center).

The ball has three forces applied: the force applied by the wall ($\vec{T}$), the gravity force $m\vec{g}$, and the external force $\vec{F}$. All the lines defined by these vectors must intersect in a single point. Indeed, suppose that the line defined by the force $\vec{F}$ intersects the vertical axis of the ball in a point, different from Q. Then it would have a non-zero torque with respect to the point Q — unlike the other two forces, causing imbalance of torques.

Now let us consider the torque balance with respect to O. The torque of the gravity force mgR is balanced by the torque of F; so, in order to have as small as possible force F, its lever arm must be as long as possible. Hence, Q must be as far away as possible from O, i.e. coincide with A, and PA must be perpendicular to OA (this answers the question ii). Finally,

$$F_{\min} = mgR/OA = mg/\sqrt{1+\mu^2} \approx 800\,\mathrm{N}.$$