Recall the parallel-axis theorem, $I_\parallel = I_{\text{CM}} + Md^2$, and the Gauss law, $\oint_S \mathbf{g} \cdot \mathrm{d}\mathbf{A} = -4\pi G M_{\text{enc}}$.

Thesis (from Physics.info)

A roll of toilet paper is held by the first piece and allowed to unfurl vertically downward. The roll has outer radius R, inner radius r, and mass M. Assuming the outer diameter of the roll does not change significantly during the fall, determine the tension, T, in the sheets and the translational acceleration, a, of the roll. (Hint: The moment of inertia of a hollow cylinder having inner radius r, outer radius R, and mass M with respect to an axis along its height and passing through its center is $I_{CM} = \frac{1}{2}M(R^2 + r^2)$.)

Antithesis

A thin rod of length L uniform mass M is standing vertically upward on a horizontal plane on its short side. Suppose the rod is tipped over, making a free fall without slipping. Find the linear speed at the tip of the rod just before it touches the ground. (Hint: The moment of inertia of a thin rod of length L and uniform mass M about its center of mass is $I_{\text{CM}} = \frac{1}{12}ML^2$.)

Synthesis

Consider an infinite slab of uniform mass density ρ and thickness h, extending along the xy plane, centered at the origin (so that the slab ends at the planes defined by $z = \pm h/2$). Suppose we carve out a sphere of radius $r < h/2$ centered at the origin from this slab. Find the gravitational field, $\mathbf{g}$, at a point P located along the positive z axis at $z = d > h/2$.