University Karlruhe - International Department

Pre-Semester Physics - Exercises Summer 2009

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1. Exercise

A uniform plate of radius $R = 2,5m$ and mass $m = 1000\,\text{kg}$ is pivoted at its symmetry axis (i.e. an axis through the center of mass S).

(i) Determine the moment of inertia Θ. To this end integrate small circular rings of volume $dV = 2\pi r dr$.

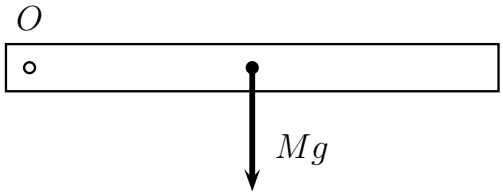
(ii) A constant moment of torque M acts on the plate. How large must M be, such that the body reaches an angular velocity $\omega_1 = 10\frac{1}{s}$ after $t_1 = 10\text{min}$.

(iii) How often did the plate turn around during this time?

(iv) How large is the angular momentum L and the kinetic energy E_{rot} of the plate after t_1?

2. Exercise

A uniform rod of mass M and length L is pivoted at one end (axis O). It is held horizontal and released. The pivot is frictionless.



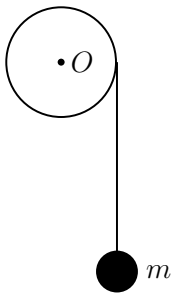
(i) What is the moment of inertia of the rod with respect to the axis of rotation?

(ii) Find the angular acceleration $\dot{\omega}$ of the rod immediately after its release.

(iii) Find the angular velocity of the rod when it reaches the vertical position.

3. Exercise

Consider a body with mass m attached to a rope which is wound around a spool with mass M, radius r and moment of inertia Θ. The spool can rotate around the axis O. Neglect friction and assume that the string pulls without slipping.



(i) Find the tension in the string and the acceleration of the mass m.

4. Exercise (more advanced)

Find the moment of inertia for a cylinder with radius r, height l and mass m. Use cylindrical coordinates (r, ϕ, z)

$$\begin{pmatrix} x \\ y \\ z \end{pmatrix} = \begin{pmatrix} r\cos\phi \\ r\sin\phi \\ z \end{pmatrix}$$

and take the z-axis as the axis of rotation.

Note: The volume element dV is in this representation given by

$$dV = r dr\, d\phi\, dz$$