Karlsruhe Institute of Technology - International Department GmbH

Pre-Semester 2010 - Physics Course - Extra Tutorial

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Sheet 5
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1. Moment of Inertia of a Hammer

We consider a hammer which consists of two perpendicular rods with masses $m_1 = 0.5\,\mathrm{kg}$ and $m_2 = 1.5\,\mathrm{kg}$, and lengths $l_1 = 0.3\,\mathrm{m}$ and $l_2 = 0.2\,\mathrm{m}$ (neglect their lateral extent). One of the ends of the first rod is attached to the center of the second rod. Calculate the moment of inertia Θ of the hammer with respect to the axis which goes through the first rod's other end and which is perpendicular to both rods.

Note: The moment of inertia of a rod of length l_r (and negligible lateral extent) and mass m_r with respect to an axis through the center of mass and perpendicular to the rod is

$$\Theta_{\mathrm{cm}} = \frac{1}{12} m_r l_r^2.$$

2. Parallel-Axis Theorem

Consider a rigid body of mass $m = 1\,\mathrm{kg}$, and two possible axes which are parallel to each other. Their distances to the body's center of mass are $s_1 = 1\,\mathrm{m}$ and $s_2 = 2\,\mathrm{m}$. If the body's moment of inertia with respect to the first axis is $\Theta_1 = 5\,\mathrm{kg\,m^2}$, what is its moment of inertia with respect to the second axis?

3. Physical Pendulum

Consider a thin rod of length $l = 2\,\mathrm{m}$ (neglect its lateral extent) and (uniformly distributed) mass $m = 3\,\mathrm{kg}$. Two point masses are attached to it: the first one, $m_1 = 4\,\mathrm{kg}$, in the middle, and the second one, $m_2 = 1\,\mathrm{kg}$ at one of its ends. At its other end the rod is hinged such that it may rotate around a perpendicular axis.

(a) With respect to the described axis, what is the moment of inertia Θ of the given pendulum?

(b) What is the moment of torque M acting on the pendulum due to gravity, if it makes an angle α with the vertical?

(c) Give the equation of motion (for α) and approximate it for small α.