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http://exp-astro.de/mechanik

Übungen zur Experimentalphysik I (Mechanik)
Aufgabenblatt 5 von 6
Abgabe im OLAT: Montag, 07.12.2020, 18:00 Uhr

GOETHE UNIVERSITÄT FRANKFURT AM MAIN

When you start working on a problem, first draw a sketch.

Problems 3 and 4 require the parallel axis theorem (Satz von Steiner).

1) Kitchen scale not working...
Determine the mass of a spoon by comparing to a known mass (Package of salt, cup of yoghurt, ...). Use the balance condition for rigid bodies.
Document your experiment with a video or with photos.

2) Moment of inertia
Calculate the momenta of inertia of the following solids for a rotation around axes through their center of mass:
a) A cuboid with edge lengths a, b and c, which is rotating parallel to c.
b) A hollow cylinder with inner radius r_i and outer radius r_a, which rotates around the symmetry axis.
c) A massive sphere with radius r.
Use

$$J = \int r^2 \mathrm{d}m$$

and suitable coordinate systems.

3) The spinning chair
A person is sitting on a spinning chair with a weight in each hand. The arms are stretched out. The person and the spinning chair have a total moment of inertia of $J_0 = 4$ m^{2}kg with regard to the rotation axis. The distance between the axis and one weight is $r_1 = 90$ cm with stretched arms. Consider the weights to be point-like with a mass of $m = 10$ kg each. Neglect friction.
a) First, the spinning chair is at rest. A second person pulls tangential at one of the masses. After $t = 0.5$ s the person and the chair are rotating at constant angular velocity $\omega_1 = 2{,}5$ 1/s. What is the total angular momentum L_1 of the system? What was the mean tangential pulling force by the second person?
b) The person on the chair pulls the weights closer to the center. The distance between the axis and the weights is now $r_2 = 40$ cm. What is the angular velocity ω_2? What amount of work was performed?
c) The person on the chair drops the weights. How does the rotational frequency change?
(Neglect the masses of the arms.)

4) Somersault on a motorcycle

Stuntwoman Carmen (2nd exercise sheet) has learned a lot about the moment of a torque in the lectures. She realizes that when she jumps off the cliff with her motorcycle she would rotate. By which angle would the motorcycle rotate until reaching the ground when Carmen was driving at 45, 90, 180 km/h towards the end of the cliff? Use a cuboid with length 2 m and height 1 m, with the center of mass 1 m above ground, to approximate Carmen and her motorcycle. The axles are located at the edges. Neglect the masses of the wheels and the axles, as well as any suspension.