Ausgabe am 07. Dezember 2020
Besprechung in den Tutorien am 15./16. Dezember 2020

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http://exp-astro.de/mechanik

Übungen zur Experimentalphysik I (Mechanik)
Aufgabenblatt 6 von 6
Abgabe im OLAT: Montag, 14.12.2020, 18:00 Uhr

GOETHE UNIVERSITÄT FRANKFURT AM MAIN

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

1) Christmas Eggs

An ellipsoid is defined by

$$\frac{x^2}{a^2} + \frac{y^2}{b^2} + \frac{z^2}{c^2} = 1. \tag{1}$$

Rotating around the z axis its moment of inertia is

$$J = \frac{4}{5}\rho\pi abc(a^2 + b^2) \tag{2}$$

Make an ellipdois spin upright (cooked egg, American Football, ...) Wait until it tips. Determine the angular velocity right after tipping. Calculate the angular velocity right before tipping. Document your experiment with a video or with photos.

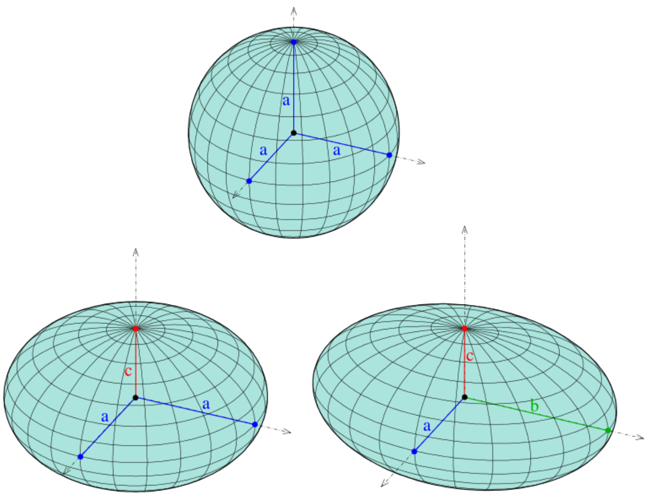

Abbildung 1: Example of ellipsoids. (Ag2gaeh, via Wikimedia Commons)

2) Down the slope

A massive cylinder (radius R), a hollow cylinder (radii $R_{\text{inner}} = 0.5\,R_{\text{outer}}$, R_{outer}) and a massive sphere (radius R) roll down an inclined plane. All bodies roll down a distance of 1 m to the end of the plane. What is their velocity at the end of the plane? Which velocity would a skier have sliding down the same plane and distance without friction?

3) Vinyl

Margarete is listening to brass music on a record. The record has a diameter of 25 cm, a weight of 200 g and plays at 45 turns per minute. The plate below the record has a diameter of 27 cm and a weight of 800 g.

a) Calculate the moment of inertia and the rotation energy of the record.

b) Repeat the calculation of part a) for the system of the record and the plate below.

c) When Margarete starts her player it accelerates (a = const) to the final velocity within 3 seconds. Which power does the player need? Draw the power as a function of time.

d) Julia does not like Margarete's brass music. She pulls out the player's plug and places a spherical rock (diameter 10 cm, density 4 g/cm^3) on top of the middle of the record. Calculate the moment of inertia of the system and its rotational velocity. (Hint: Which variable is preserved? Compare to the inelastic collision.)

4) Non-inertial reference frame

An inductile rope runs over a winch. We neglect friction. On one side a mass M is tied to the rope. On the other side, a mass $M + m$ is tied to the rope. The winch is pulled upwards with an acceleration of a. Calculate the acceleration of the masses and the force on the rope F_S. (Neglect the mass of the winch. The winch may turn.)

5) Another non-inertial reference frame

Two masses m are tied to a massless rope with length l = 40 cm. The rope is fixed to a rod in the middle. What is the angle between the rope on one side and the rod if the rod rotates at 80 turns per minute?