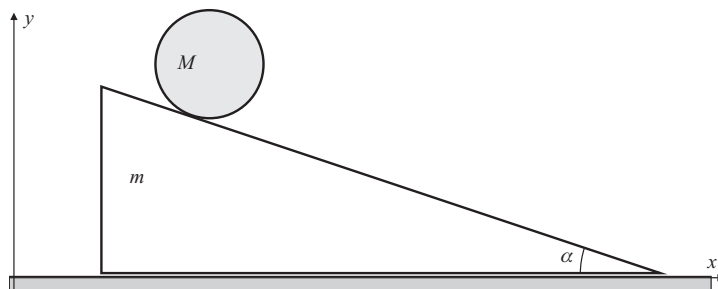


Rigid Body Dynamics, SG2150

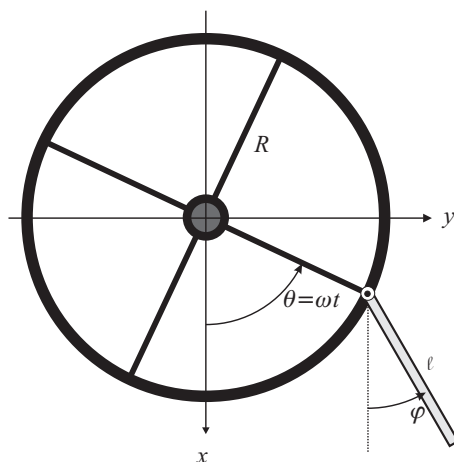
Exam, 2012 02 18, kl 15.00-19.00

Calculational problems

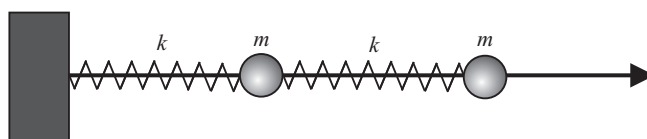
Problem 1: A wedge of mass m can slide on a smooth horizontal plane. A cylinder of mass M and radius r can roll without slipping on the wedge. The cylinder is released from rest and starts to roll down the incline on the wedge, which makes an angle α with the horizontal. Find the acceleration of the wedge.



Problem 2: A rod of length ℓ hangs at the edge of a vertical wheel of radius R (like a gondola on a ferris wheel). The wheel rotates with a constant given angular velocity ω about a horizontal axis through the midpoint. Find the Lagrangian and the equation of motion of the rod. Find the angular frequency of small amplitude motions of the rod in the two limiting cases $R\omega^2 \ll g$ and $R\omega^2 \gg g$. In the latter case the motion is of small amplitude relative the rotating system of the wheel.

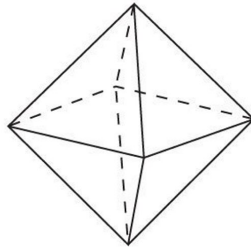


Problem 3: Calculate the angular eigen frequencies for the two degree of freedom coupled oscillator problem in the figure below. The spring on the left is attached to a fixed wall at its left end. The two identical particles of mass m can slide with negligible friction along the horizontal track. The two springs of stiffness k are also identical.



Idea problems:

Problem 4: Twelve identical slender homogeneous rods, each of mass m and length a are welded together at the endpoints so that they constitute the edges of a regular octahedron. Find the moment of inertia of this body with respect to an axis through the midpoint.



Problem 5: Find the components of the vector equation $\dot{\mathbf{L}} = \mathbf{M}$ for a rigid body using the body fixed principal axes system of basis vectors, *i.e.* Euler's dynamic equations.

Problem 6: Use the Lagrange formalism to show that any system with a Lagrangian that does not depend explicitly on time is characterized by a conserved quantity (normally the energy).

Each problem gives maximum 3 points, so that the total maximum is 18. Grading: 1-3 F; 4-5 FX; 6 E; 7-9 D; 10-12 C; 13-15 B; 16-18 A.

Allowed equipment: Handbooks of mathematics and physics. One A4 size page with your own compilation of formulas.