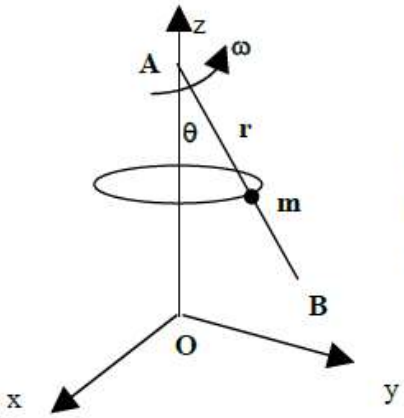
METÓDY RIEŠENIA FYZIKÁLNYCH ÚLOH 3 leto21 – Príklady 1

Cvičenie 18.2.2021

Príklad 1

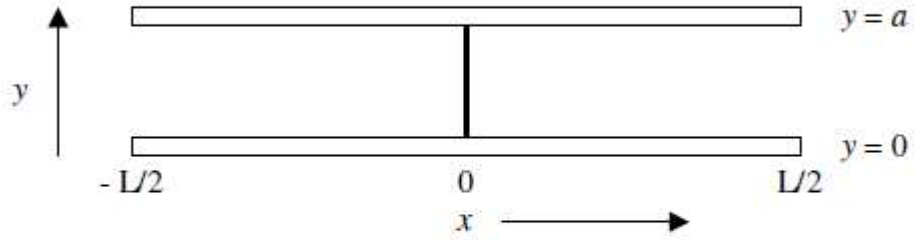
A bead of mass m moves along a frictionless wire AB. The wire is fixed at point A and rotates with angular frequency ω about the z axis. θ is fixed



a. Determine the Lagrangian in terms of r, θ and azimuthal angle
b. Determine the Lagrange equation as a function of m, $\frac{dr}{dt}$, ω, r and θ.
c. Solve the equation of motion.

Príklad 2

PROBLEM: As shown in the figure, two parallel conducting plates of dimension $L \times L$ are separated by a distance $a \ll L \to \infty$ and are at electrical potential $V = 0$. A thin charged membrane of height a and length L is inserted perpendicular to the plates at $x = 0$. The potential on this membrane is $V(0, y) = V_0 \sin(\pi y/a)$. The plates and the membrane extend a distance L in the direction perpendicular to the plane of the figure.



(a) Find the electrical potential, $V(x, y)$, in the region between the plates to the right of the membrane (i.e., for $x > 0$). (You may ignore values of $x \geq L/2$.)

(b) Find the sign and magnitude of the charge density, $\sigma(x)$, on the conducting plates at $y = 0$ and $y = a$ to the right of the membrane, $x > 0$.

(c) Find the magnitudes and directions of the forces on the entire upper and lower plates.

Príklad 3

PROBLEM: In studying the hydrogen atom one takes the proton to be a point charge with mass M. Suppose instead that the proton charge is distributed uniformly within the volume of a sphere with radius $r_0 = 10^{-15}$ m.

(a) Using perturbation theory, calculate the shift in energy of the $1s$ level of hydrogen to first order in the perturbation.

(b) Give an order of magnitude estimate of the ratio of the $2p$ and $1s$ level shifts.

Príklad 4

PROBLEM: Molecules of an ideal gas have internal energy levels that are equidistant, $E_n = n\varepsilon$, where $n = 0, 1, \ldots$ and ε is the level spacing. The degeneracy of nth level is $n + 1$. Find the contribution of these internal states to the energy of the gas of N molecules at temperature T.