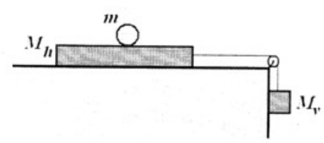
METÓDY RIEŠENIA FYZIKÁLNYCH ÚLOH 2 zima23 – Príklady 4

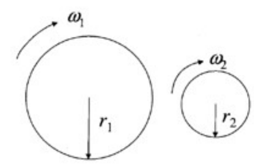
Cvičenie 2.11.2023

Príklad 1

A block of mass M_h slides without friction on a horizontal table. It is connected by a massless rope passing over a massless frictionless pulley to a second hanging mass M_v pulled downward by gravity. A sphere of mass m and radius R, initially at rest, rolls without sliding on the top surface of the first block. Find the resulting acceleration of the mass M_v and the center of mass of the sphere.



Two uniform cylinders spin independently about their axes (the axes are parallel to each other). The first has radius r_1 and mass m_1, the other has radius r_2 and mass m_2. Initially they rotate in the same sense of rotation with angular speeds ω_1 and ω_2 respectively. They are then brought together so that they touch. After the steady state is achieved, what is the final angular velocity of cylinder 1, ω_1'?



Príklad 2

A spherical capacitor consists of two concentric conducting spheres of radii a and b. The capacitor is filled with dielectric material whose dielectric constant varies according to:

$$\varepsilon(r) = \begin{cases} \varepsilon_1 = \text{const}, & \text{for } a < r < c \\ \varepsilon_2 = \text{const}, & \text{for } c < r < b \end{cases}$$

The charge on the *inner* conducting sphere is Q.

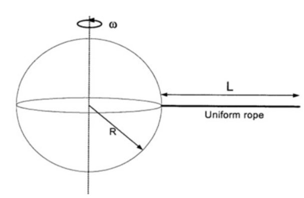
(a) Find the electric field inside the capacitor as a function of r.

(b) Find the capacitance of this capacitor.

(c) Find the density of the bound charge on the boundary between the dielectric layers at $r = c$.

Príklad 3

A recent Science Times article featured the concept of a "space elevator". This is a free hanging rope in stationary orbit around the earth above the equator. You could send an elevator up this rope to launch objects into space at less cost than required for shuttle flights. Imagine such a rope just reached the earth's surface. Find an expression for the tension in the rope as a function of height, *y*, off the earth's surface. Assume the rope has length *L*, and mass *m*, and that the earth has radius *R* and mass *M* and rotates at angular velocity ω. What length, *L*, allows the rope to hang freely (i.e. without being attached to the earth's surface) ?



Príklad 4

Od stojaceho pozorovateľa sú vo vzdialonosti $L, 2L, 3L$ tri lampy, ktoré sa v časoch ct_1, ct_2, ct_3 (tak ako ich odmeria tento stojací pozorovateľ) rozsvietia. To znamená že na všetky strany začnú vysielať svetlo.

- Ak platí $ct_1 = 4L, t_2 = 3L, t_3 = 5L$, v akom poradí uvidí pozorovateľ rozvietenie lámp? V akých časoch?
- Po ceste popri lampách ide ddruhý pozorovateľ na aute. V akej vzdialenosti sú pre neho od seba lampy? V akom poradí nastane v jeho sústave rozvietenioe lámp? V akom poradí toto rozvietenie uvidí?
- Existuje pozorovateľ, pre ktorého by rozvietenie prvej a tretej lampy nastalo v opačnom poradí ako pre stojaceho pozorovateľa? Existuje pozrovateľ, ktorý ich uvidí rozvietiť sa v opačnom poradí?

Úlohu stačí riešiť graficky v časopriestorovom diagrame. V tomto príklade si treba rozmysliet rozdiel medzi časom, v ktorom rozvietenie lampy pre pozorovateľa nastane a časom, v ktorom toto rozvietenie uvidí (tj. k nemu dorazí jej svetlo).