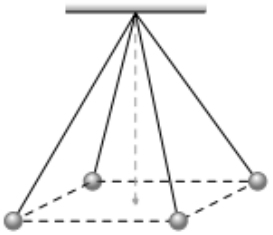
METÓDY RIEŠENIA FYZIKÁLNYCH ÚLOH 1 leto24 – Príklady 7

Cvičenie 9. 5. 2024

Príklad 1

22 Jonka doma našla štyri rovnaké homogénne paličky s hmotnosťou 2 kg a dĺžkou 2 m. Všetky ich jedným koncom zavesila zo stropu tak, že viseli z jedného bodu. Na spodný koniec každej paličky pripla nehmotný bodový náboj 10^{-4} C, takže sa začali odpudzovať. Aký uhol zvierajú paličky so zvislicou, keď je sústava v rovnovážnej polohe?

Táto úloha nemá analytické riešenie. Nebojte sa použiť kalkulačku. Výsledok odovzdajte s presnosťou na 1°.

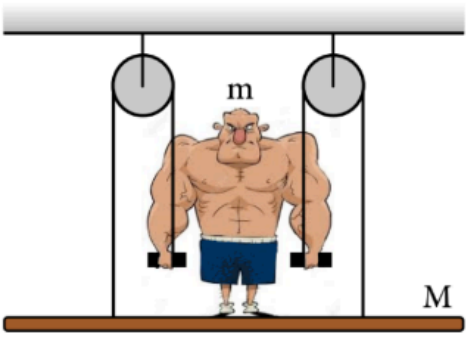


Aká je perióda malých kmitov okolo tejto rovnovážnej polohy?

Príklad 2

Ak viete, že v nasledujúcich úlohách je práve jeden z ponúkaných výsledkov správny, nájdite ho bez toho, aby ste úlohu počítali.

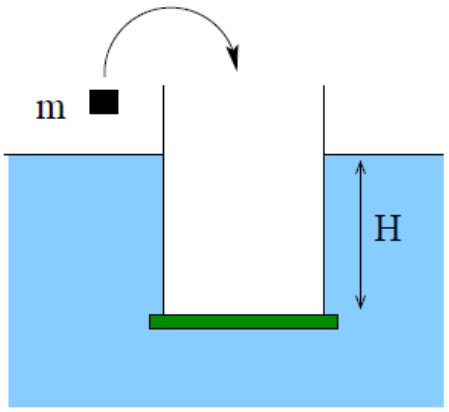
Príklad 1. *Silák Patrícius Ozrutný má hmotnosť m. Dnes chce v cirkuse predviesť, ako sa iba pomocou kladiek zdvihne spolu s plošinou hmotnosti $M < m$, na ktorej stojí. Akou silou musí ťahať za každé lano, aby sa mu to podarilo?*



1. $F = \frac{2M+m}{3}g$
2. $F = \frac{mM}{m+M}g$
3. $F = \frac{M+m}{4}g$
4. $F = \sqrt{\frac{(M-m)^2}{16}}g$
5. $F = \sqrt{\frac{(m+M}{2}g}$
6. $F = \frac{M-m}{2}g$

Príklad 3

An open cylinder with thin light (water-tight) attached bottom is submerged into water to depth H. A weight m is placed on the bottom of the cylinder. Find the minimal weight m, and its position on the bottom, required to separate the bottom from the cylinder. The diameter of the cylinder is D, you may assume that the size of the weight is much smaller than D.



Príklad 4

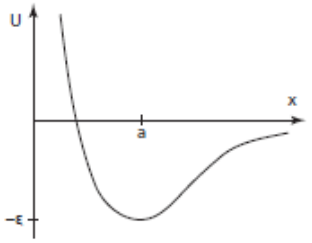
A long, solid cylindrical conductor has a radius b, length L, and electrical conductivity σ_c. A uniform current flows through it when a voltage difference V_0 is applied between the ends.

(a) Use the Poynting vector to calculate the total power flow into (or out of) the cylindrical region inside radius $s = b/2$. Does the power flow into this region or out of it?

(b) Calculate the Ohmic heating in the region $s \leq b/2$, and compare this to the power flow calculated in part (a).

Príklad 5

PROBLEM: The figure below shows a generic potential for atoms in a solid lattice. Assign reasonable numbers for the scale of the equilibrium location, a, and the depth of the potential well, ε for, say, iron. Now imagine a steel fiber 1 m long and 100 μm in diameter suspending a 1 kg mass in normal gravity. How much will the fiber stretch, based on your estimates for a and ε? Hint: first work out a spring constant, k.



Príklad 6

PROBLEM: Orbital precession due to a quadrupole perturbation.

As a result of the Earth's aspherical mass distribution, its gravitational potential has the form

$$U(\vec{r}) = -\alpha\left(\frac{1}{r} + \beta\frac{3z^2 - r^2}{r^5}\right) ,$$

where the z-axis is the Earth's axis of rotation, and α and β are constants. The corresponding gravitational force thus contains a (small) non-central component.

(a) Determine the equations of motion of a (non-relativistic) particle of mass m in this field. (Hint: try using rectangular coordinates.)

(b) Determine the rate of change of the angular momentum vector $\vec{L}$ of the particle. Write the answer in terms of $\vec{r}, \hat{z}$ and the given constants.

(c) Consider a particle moving initially in an approximately circular orbit, with radius a and angular velocity $\dot{\varphi} = \omega$. Let the normal to the plane of the orbit lie initially in the x-z plane, at an angle θ with the z-axis, as indicated in the figure. Assume $|\frac{d\vec{L}}{dt}|$ to be sufficiently small that over one period the orbit can be considered to be an unperturbed circle. Find the time average $\left\langle \frac{d\vec{L}}{dt} \right\rangle$ over one period of this circular orbit.