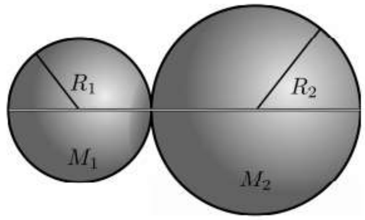
METÓDY RIEŠENIA FYZIKÁLNYCH ÚLOH 1 leto22 – Príklady 2

Cvičenie 10.3.2022

Príklad 1

Vo vzdialenej hviezdnej sústave si poletuje zvláštna dvojplanéta. Skladá sa z dvoch dotýkajúcich sa planét s polomermi R_1, R_2 a hmotnosťami M_1, M_2. Touto dvojplanétou vedie rovná diera prechádzajúca stredmi oboch planét. Do tejto diery pustíme pri povrchu planéty s hmotnosťou M_1 skúšobné teliesko. Akou rýchlosťou vyletí na druhej strane diery?



Príklad 2

V nasledujúcom je vždy práve jedno riešenie úlohy správne. Nájdite ktoré to je bez toho, aby ste úlohu počítali.

Priklad 8. *Pohyblivé schody prenesú stojaceho pasažiera z jedného podlažia na druhé za čas t_1. Ak pohyblivé schody stoja, prejde po nich pasažier z jedného podlažia na druhé za čas t_2. Za akú dobu prejde pasažier z jedného podlažia na druhé ak kráča po pohybujúcich sa schodoch (pasažier ide v smere pohybujúcich sa schodov)?*

a. $T = \frac{t_1^2}{t_1+t_2}$

b. $T = \frac{t_1 t_2}{t_1+t_2}$

c. $T = \frac{t_1 t_2}{t_1-t_2}$

d. $T = \frac{t_1^2 t_2^2}{t_1^3+t_2^3}$

e. $T = \frac{t_1^2+t_2^2}{t_1+t_2}$

f. $T = \frac{t_1^2-t_2^2}{t_1^2+t_2^2}$

Priklad 26. *Na urýchľovací LHC v CERNe sa pohybujú po kruhovej dráhe s dĺžkou l protóny s energiou E. Ak poznáte pokojovú hmotnosť protónu m_0 a jeho náboj q, nájdite magnetické pole, ktoré musí pôsobiť na urýchľovaný protón.*

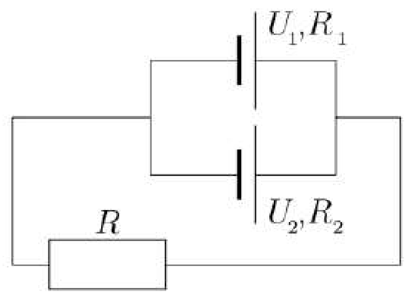
a. $B = \frac{2\pi E}{lqc}\sqrt{2 - \left(\frac{m_0 c^2}{E}\right)^2}$

b. $B = \frac{2\pi E}{lqc}\sqrt{1 + \left(\frac{m_0 c^2}{E}\right)^2}$

c. $B = \frac{2\pi E}{lqc}\sqrt{1 - \left(\frac{m_0 c^2}{E}\right)^2}$

d. $B = \frac{2\pi E}{lqc}\sqrt{1 - \left(\frac{m_0 c^2}{2E}\right)^2}$

Priklad 21. *Kleofáš má rezistor s odporom R a dva zdroje s napätím U_1 resp. U_2 a vnútornými odpormi R_1, resp. R_2. Zapojil ich podľa obrázka. Aký prúd preteká rezistorom s odporom R.*



a. $I = \frac{U_1 R_2 + U_2 R_1}{R_1 R_2 + R(R_1+R_2)}$

b. $I = \frac{U_1 R_2 + U_2 R_1}{2R_1 R_2 + R(R_1+R_2)}$

c. $I = \frac{U_1 R_1 + U_2 R_2}{R_1 R_2 + R(R_1+R_2)}$

d. $I = \frac{(R_1+R_2)^2(U_1 R_2 + U_2 R_1)}{4\left(R_1^2 R_2^2 + R R_1 R_2 (R_1+R_2)\right)}$

e. $I = \frac{U_1 R_2 + U_2 R_1}{2R_1 R_2 - R(R_1+R_2)}$

Príklad 3

PROBLEM: Starting from rest at $(x, y) = (0, 0)$, a particle slides down a frictionless hill whose shape is given by the equation $y = -ax^n$, $a > 0$ and $n > 0$. Determine the range of allowed n for which the particle leaves the surface, and the x location at which this occurs. Assume gravity is constant, in the $-y$ direction.

Príklad 4

Klingon engineers have constructed a fiendish trap for unsuspecting, passing spaceships. It consists of a spherical attractive well that can be approximated by the potential

$$V(r) = \frac{-K^2 m}{r^4}$$

where m is the mass of the spaceship (assumed to be much smaller and lighter than the trap).

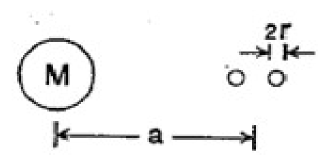
a) Show that the period of a circular orbit of radius r is $\pi r^3/K$ but that circular orbits are unstable as the Klingon engineers had anticipated.

b) The Starship Enterprise approaches the trap with speed v and shuts down its engines in order to avoid detection. What is Captain Kirk's minimum prudent impact parameter in order to avoid capture?

c) Now assume that the trap is moving through space at a constant velocity. It acts as a cosmic "vacuum cleaner", sweeping up interstellar dust which can be regarded as having uniform density ρ and negligible random motion. Calculate the dust mass collection rate.

Príklad 5

Two small spherical objects, each of radius r and uniform density ρ are a distance a from a large mass M. Note that $r/a \ll 1$. Find the critical density ρ_c above which the two small objects will not be pulled apart by M.



Príklad 6

A coaxial cable consists of two cylindrical conductors. The inner conductor is a solid cylinder of radius a, and the outer conductor is a thin cylindrical shell of radius b. A current I flows in the inner conductor and current $-I$ flows in the outer conductor. Assume that the current in the inner conductor is uniformly distributed across the cross-section of the conductor.

a) Show that the inductance L per unit length l is given by $\frac{L}{l} = \frac{\mu_0}{2\pi}\ln\frac{b}{a} + \frac{\mu_0}{4\pi}$ (you may alternatively give the result in CGS units).

b) What gives rise to the second term in the result in part a? To answer this, consider how the result changes if you assume the inner conductor is a thin cylindrical shell of radius a.