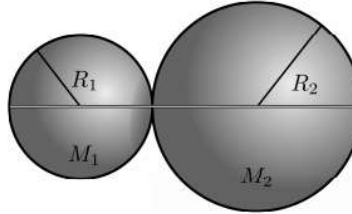


METÓDY RIEŠENIA FYZIKÁLNYCH ÚLOH 1 leto23 – Príklady 2

Cvičenie 28.2.2023

Príklad 1

Vo vzdialenej hviezdnej sústave si poletuje zvláštna dvojplanéta. Skladá sa z dvoch dotýkajúcich sa planét s polermi 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.

Príklad 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. $T = \frac{t_1^2}{t_1+t_2}$

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

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

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

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

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

Príklad 26. Na urýchľovaci 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.

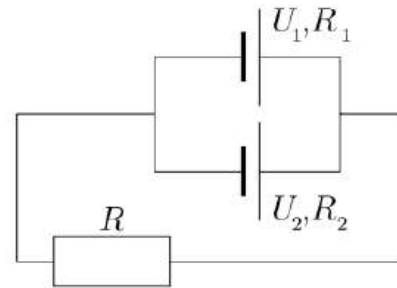
a. $B = \frac{2\pi E}{lqc} \sqrt{2 - \left(\frac{m_0 c^2}{E}\right)^2}$

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

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

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

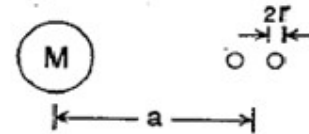
$$V(r) = \frac{-K^2 m}{r^4}$$

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

- 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.
- 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?
- 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.

- 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).
- 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 .

