METÓDY RIEŠENIA FYZIKÁLNYCH ÚLOH 3 leto20 – Príklady 5

Cvičenie 12.5.2020

Príklad 1

Príklad 6.4. Od stojaceho pozrovateľa sú vo vzdialonosti $L, 2L, 3L$ tri lampy, ktoré sa v časoch ct_1, ct_2, ct_3 (tak ako ich odmeria tento stojaci 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 pozrovateľ 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).

Príklad 2

Consider the relativistic form of Newton's Second Law.

• Show that when $\mathbf{F}$ is parallel to $\mathbf{v}$

$$F = m\left(1 - \frac{v^2}{c^2}\right)^{-3/2}\frac{dv}{dt} \tag{33}$$

where m is the mass of the object and v is its speed.

A charged particle moves along a straight line in a uniform electric field $\mathbf{E}$ with speed v.

• If the motion and the electric field are both in the x direction, show that the magnitude of the acceleration of the charge q is given by

$$a = \frac{dv}{dt} = \frac{qE}{m}\left(1 - \frac{v^2}{c^2}\right)^{3/2} \tag{45}$$

• Discuss the significance of the dependence of the acceleration on the speed.

• If the particle starts from rest $x = 0$ at $t = 0$, find the speed of the particle and its position after a time t has elapsed.

• Comment of the limiting values of v and x as $t \to \infty$.

The force $\mathbf{F}$ on a particle with rest mass m and charge q moving with velocity $\mathbf{v}$ in a magnetic field $\mathbf{B}$ is

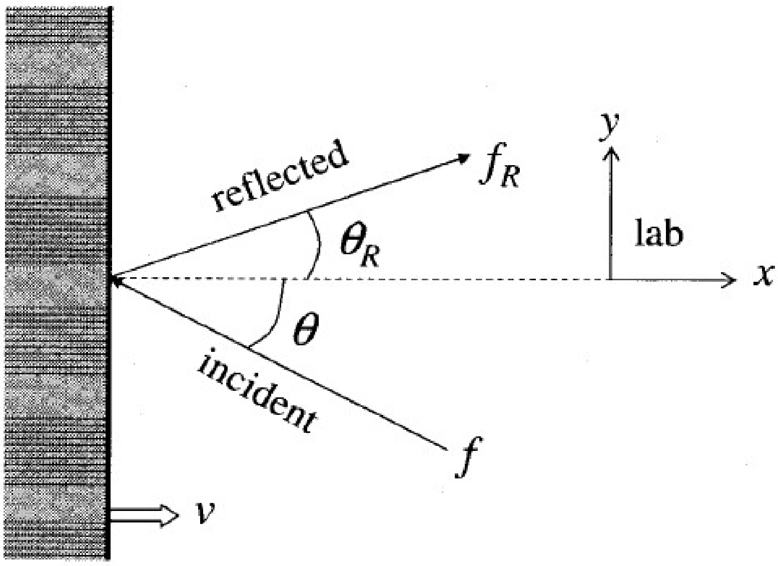
$$\mathbf{F} = q\mathbf{v} \times \mathbf{B}. \tag{54}$$

• If the particle moves in a circular orbit with a fixed speed v in the presence of a constant magnetic field, use Newton's Second Law to show that the frequency of its orbital motion is

$$f = \frac{qB}{2\pi m}\left(1 - \frac{v^2}{c^2}\right)^{1/2} \tag{55}$$

Príklad 3

3. A monochromatic beam of light is incident on a flat mirror. With respect to the laboratory, the mirror is traveling in at relativistic speed v in the $+x$ direction. (The plane of the mirror is perpendicular to the x-axis.) Also with respect to the laboratory, the incident light beam has frequency f and is traveling at angle θ with respect to the x-axis. Find the frequency f_R and the angle θ_R of the reflected light beam as measured in the laboratory.



Príklad 4

5. A photon of wavelength λ Compton scatters off a free electron (mass m) which is initially at rest. The scattered photon has wavelength λ' and scatters at an angle θ (measured from the incident direction). Express your answers in terms of m, λ, θ and h.

(a) Calculate λ'.

(b) Calculate the kinetic energy of the recoil electron.