(KTXFI2EBNF) Physics II. Exercises

November 10, 2025

I. Relativistic Kinematic

1. A spaceship with a rest length of 100 m passes in front of an Earth observer in $4\,\mu s$. What is its velocity relative to the Earth?
2. We study an electron in a radioactive particle beam as it passes through the laboratory. It is found that, as measured in the laboratory, the average lifetime of the particle is 20 ns; after this time the particle decays. The average lifetime measured in the reference frame attached to the particles is $7.5\,ns$. What is the propagation velocity of the particle beam?
3. A certain bacterium doubles its population in 20 days. Two such bacteria are placed in a spaceship and sent on a 1000-day space journey. During the trip, the spaceship moves at a constant speed of $0.995\,c$. How many bacteria will be on board at the moment of return?
4. Aladár drives a nail into point $P_1(4000\,\mathrm{m}, -100\,\mathrm{m}, 200\,\mathrm{m})$ in the coordinate system K. At that moment, the clock in K shows $t = 15\,\mu\mathrm{s}$. At the same time in K, Balázs drives another nail into point $P_2(3000\,\mathrm{m}, 500\,\mathrm{m}, 150\,\mathrm{m})$ of the same coordinate system. (The two events occur simultaneously in K.) Calculate the time interval between the two events in a reference frame K' moving at a uniform velocity $v = 2 \cdot 10^8\,\mathrm{m/s}$, parallel to the x-axis.

II. Relativistic Dynamics

(a) A particle moves with a velocity such that $\frac{v}{c} = 0.99$. Determine the value of $\frac{m}{m_0}$!

(b) Determine the relativistic mass and the velocity of an electron whose kinetic energy is 100 keV ($1.6 \cdot 10^{-14}\,\mathrm{J}$). The rest mass of the electron is $9.11 \cdot 10^{-31}\,\mathrm{kg}$.

(c) Calculate the rest energy of an electron, corresponding to its rest mass of $9.11 \cdot 10^{-31}\,\mathrm{kg}$, in joules and in electronvolts! ($1\,\mathrm{MeV} = 1.6 \cdot 10^{-13}\,\mathrm{J}$)

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