TFY4345 Classical Mechanics. Department of Physics, NTNU.

ASSIGNMENT 11

Question 1

For the reaction p + n $\rightarrow$ p + n + p + $\overline{\text{p}}$, find the threshold kinetic energy $T_p = T_n$ when the proton and the neutron collide head-on with equal speed.
See lecture notes for the case with the neutron initially at rest.

Question 2

Assume the inertial system S' moves with velocity v relative to S, along the x_3 axis. Use the field tensor $F_{\mu\nu}$ and the Lorentz transformation $L_{\mu\nu}$ and derive the transformation rules for E_2, E_3, B_2 and B_3.
See lecture notes for E_1 and B_1.

Question 3

A π meson of mass m_π at rest disintegrates into a μ meson of mass m_μ and a neutrino of negligible mass. Show that the kinetic energy of the μ meson is

$$T = \frac{(m_\pi - m_\mu)^2}{2m_\pi}\, c^2.$$

Question 4

a) The constraint $y = x \tan\theta$ for a particle sliding down an incline is called

A) conservative
B) holonomic
C) canonical
D) invariant
E) cyclic
F) virtual

b) What is the value of the element ε_{333} of the Levi-Civita tensor?

A) 1
B) -1
C) i
D) $-i$
E) 0
F) π

c) What is the SI unit of the action $I = \int L\,dt$? Here, L is the system Lagrangian and t is time.

A) The same unit as for angular momentum
B) The same unit as for power
C) The same unit as for acceleration
D) Nm
E) $\mathrm{m/s^2}$
F) Dimensionless

d) If the system Lagrangian is independent of a coordinate q, this coordinate is called

A) conservative
B) holonomic
C) canonical
D) invariant
E) cyclic
F) virtual

e) A particle with mass m moves in the xy plane in a potential $V(r) = \alpha x^2 y^2$, with α a positive constant (and with a suitable unit). What is the acceleration of the particle on the y axis?

A) 0
B) $\alpha y^{3/2}/m$
C) $\alpha y^{2/3}/m$
D) $2\alpha y^{3/2}/m$
E) $2\alpha y^{2/3}/m$
F) $4\alpha y^3/m$