KING SAUD UNIVERSITY. DEPARTMENT OF PHYSICS AND ASTRONOMY

MODERN PHYSICS (351 PHYS)

PROBLEM SET 2

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PROBLEM (1)

Calculate the momentum of a proton moving with a speed of (a) 0.010c, (b) 0.50c, (c) 0.90c . (d) Convert the answers of (a)-(c) to MeV/c .

PROBLEM (2)

An electron has a momentum that is 90% larger than its classical momentum. (a) Find the speed of the electron. (b) How would your result change if the particle were a proton?

PROBLEM (3)

A proton moves at a speed of 0.95c. Calculate its (a) rest energy, (b) total energy, and (c) kinetic energy.

PROBLEM (4)

Protons in an accelerator at the CERN Large Hadron Collider at the Swiss-French borders are accelerated to an energy of 6900 times their rest energy. (a) What is the speed of these protons? (b) What is their kinetic energy in MeV?

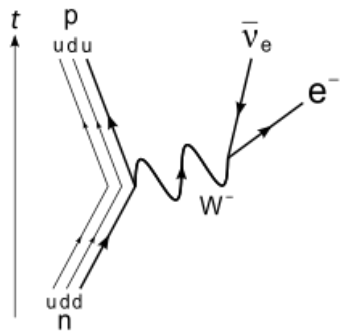
Figure 0.1: The Large Hadron Collider

PROBLEM (5)

The free neutron is known to decay into a proton, an electron, and an antineutrino $\bar{\nu}$ (of negligible rest mass) according to

$$n \longrightarrow p + e^{-} + \bar{\nu}$$

This process is called the beta decay. The decay products are measured to have a total kinetic energy of $0.781 MeV$ Show that this observation is consistent with the excess energy predicted by the Einstein massâĂŞenergy relationship.



PROBLEM (6)

An unstable particle having a mass of 3.34×10^{-27}kg is initially at rest. The particle decays into two fragments that fly off with velocities of $0.987c$ and $0.868c$ in the opposite direction. Find the rest masses of the fragments.