Modern Physics

Week 3 - Tutorial 1-2

14^{th} September, 2012

1. Energy-mass-momentum relation. Show that

$$E^2 = (mc^2)^2 + (pc)^2$$

2. Mass disintegration. A particle of mass M decays at rest into two particles, each with mass m moving in opposite directions with velocity v. Find speed of each of the particle in rest frame.

3. Deuteron disintegration into proton and neutron. Mass of a deuteron is measured to be 1875.6 MeV/c^2. The sum of masses of the constituents of deuteron (a proton and a neutron) is 1877.9 MeV/c^2. Observing that the sum of masses of constituent particles is more than the mass of deuteron, argue why the existence of deuteron is still possible. Also tell if deuteron will disintegrate into its constituent particles on its own, and if not, then why?

4. Particle in an electric field. (a). What is the kinetic energy acquired by a particle of charge q starting from rest in a uniform electric field when it falls through an electrostatic potential difference of V_0 volts?
(b). Assume the particle to be an electron and the potential difference to be 10^4 volts. Find the kinetic energy of the electron, velocity and its mass at the end of the acceleration.

5. Particle in a magnetic field. (a).Show that in a region where there is a uniform magnetic field, a charged particle moving perpendicular to the field moves in a circle whose radius is proportional to the particle's momentum.
(b). Compute the radius both classically and relativistically, of a 10 MeV electron moving at right angles to a uniform magnetic field of strength 2.0 Wb/m^2.