

Problem Set 20

(Due: April 23, 2009)

1) Jackson, problem 11.24.

The threshold kinetic energy T_{th} in the laboratory for a given reaction is the kinetic energy of the incident particle on a stationary target just sufficient to make the center of mass energy W equal to the sum of the rest energies of particles in the final state. Calculate the threshold kinetic energies for the following processes. Express your answers in MeV or GeV and also in units of the rest energy of the incident particle (unless it is a massless particle).

(a) Pi-meson photoproduction, $\gamma p \rightarrow \pi^0 p$

$$(m_p = 938.5 \text{ MeV}, \quad m_{\pi^0} = 135.0 \text{ MeV})$$

(b) Nucleon-antinucleon pair production in nucleon-nucleon collisions, for example, $pp \rightarrow ppp\bar{p}$.(c) Nucleon-antinucleon pair production in electron-electron collisions, $e^-e^- \rightarrow e^-e^-p\bar{p}$ and $e^-e^- \rightarrow p\bar{p}$ ($m_e = 0.511 \text{ MeV}$).

2) Jackson, problem 12.3.

A particle with mass m and charge e moves in a uniform, static, electric field \mathbf{E}_0 .

(a) Solve for the velocity and position of the particle as explicit functions of time, assuming that the initial velocity \mathbf{v}_0 was perpendicular to the electric field.

(b) Eliminate the time to obtain the trajectory of the particle in space. Discuss the shape of the path for short and long times (define “short” and “long” times).